MODERN WIRING

A Practical Guide for Planning, Selecting and Installing Adequate Wiring for Home and Farm

Montgomery Ward

MODERN ELECTRICAL LIVING DEMANDS

LIVING IN AN ELECTRICAL AGE

Today, more than ever before, we are living an "electrical" life. It wasn't too long ago that running water, a simple system of electric lights and perhaps an electric "ice box" were considered the utmost in modern home convenience. Today these are barest essentials at best. Since then, our scale of electrical living has advanced tremendously. Just within the past dozen years, we have come to accept and depend on food freezers, air conditioners, ranges, garbage disposers, clothes washers and dryers and many other electrical servants. But what about tomorrow? How many more new and exciting time- and work-saving servants does the future hold in store for us?

Obviously our comfort and convenience are becoming increasingly dependent upon electrical power—more than upon anything else we have in our homes! The question is —how well are our homes equipped to provide necessary electric power for operating not only today's conveniences, but also those that may be installed in the years ahead?

PURPOSES OF THIS BOOKLET ARE...

to help you plan, select and install your own modern electrical system for accommodating both your present and future electrical needs. Whether you plan to build or modernize your house, utility or farm building, you will find it helpful in getting the most for your electrical dollar. By doing the job yourself, you will be able to save up to one-half or more of the cost of having the job done.

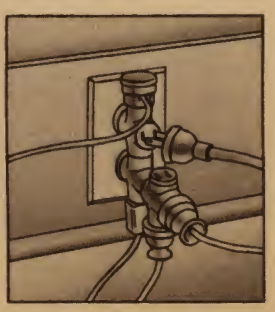
Anyone with average skill—a home owner, farmer or hobbyist can, with careful planning and the use of a few tools found in most households, install wiring so that the results will be satisfactory and conform to local and national electrical code requirements.

MOST HOMES INADEQUATELY WIRED

Electricity flows through wires in your home in much the same way that water flows through pipes. Just as the proper size pipe gives you a full supply of water at every faucet, so do the proper size wires give you an adequate supply of electricity at every outlet to handle safely your full electrical load. Each wire in your home is limited to the amount of electricity it can carry safely.

If your house is 15 or more years old, it probably has outgrown its wiring. When it was built, the wiring was probably sufficient for the basic electrical needs of its time. But as more electrical appliances were developed and introduced, you adopted newer standards of electrical living. Soon you began to run short of electrical outlets. For millions of average Americans, this problem was temporarily solved by using double or even triple outlet plugs looking much like the familiar "octopus" below.

About this time you may have noticed fuses blowing out more often. And even more disturbing, perhaps your old appliances didn't function as well as they used to, and the new ones you bought failed to perform to your expectations. Actually, your appliances were starving from lack of sufficient electricity. Your entire electrical system was feeling the pinch of inadequate wiring.



Studies indicate that even today new homes being built may suffer from inadequate wiring. This false economy is sure to cause dissatisfaction to the prospective owner.

AN ADEQUATE HOME WIRING SYSTEM

SYMPTOMS OF INADEQUATE WIRING

You don't have to be a wiring expert to recognize an inadequately wired home. You have probably noticed a number of indications which lead you to suspect your home's electrical system. You may have put the blame on the power company, or if an appliance didn't function satisfactorily, the manufacturer's products were questioned. More probably, however, the fault is with the wiring of your own house. Besides not getting full efficiency from appliances, overloaded wires heat up and waste current which you pay for. Improperly fused, they even create a fire hazard. Check the following list:

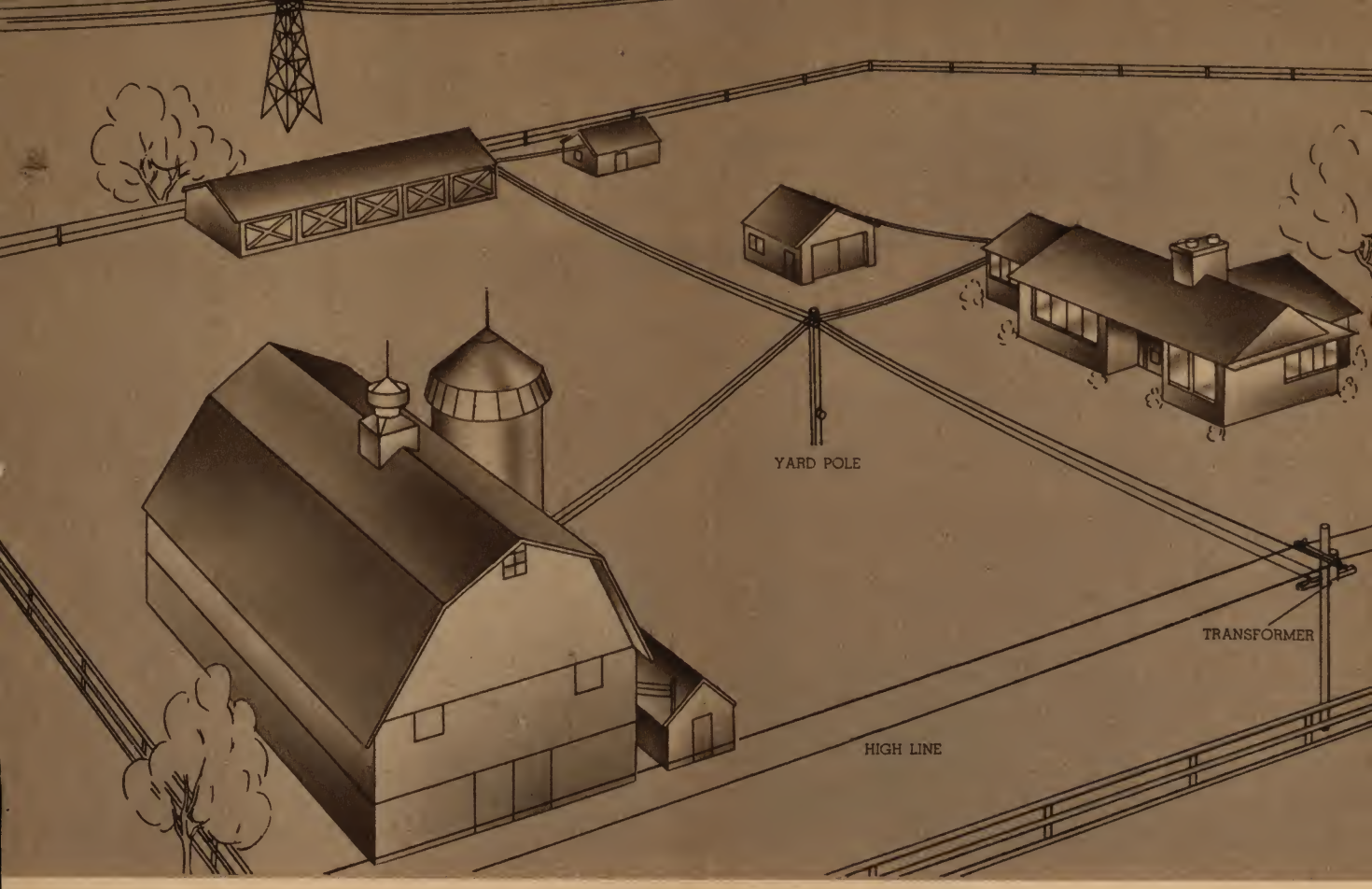
Check Here	If Any of These Conditions Exist, Your Wiring System Can Be Classed "Inadequate".
	1. Lights dim when appliances are turned on.
	2. Toasters, heaters, irons heat up too slowly.
	3. Fuses blow or circuit-breakers trip too often.
	4. Television picture shrinks in size or becomes hazy when electrical appliances are turned on.
	5. Motors overheat easily and often. This shows lack of electrical power, shortens motor life.
	6. Need for multiple or "octopus-type" connections to operate several appliances.
	7. Long cords strung around room to plug in lights.
	8. Rooms have hard-to-find pull chain light switches instead of handy wall switches.

ADEQUATE WIRING IS LOOK-AHEAD WIRING

It means capacity enough for your present electrical needs . . . and for the future. Carefully planned, full-powered wiring costs a little more to begin with, but pays for itself in the long run. Ten years from now, you can enjoy the new conveniences now being planned for you without undergoing expensive re-wiring. The chart below shows recommended wiring requirements of circuits to handle many of today's appliances:

Type of Appliance	Typical Watts	Usual Voltage	Size Wires	Fusing Recommended
Electric Range	12000	110/240	3 No.6	50-60 Amp.
Dishwasher	1200	110-120	2 No. 12	20 Amp.
Garbage Disposer	300	110-120	2 No. 12	20 Amp.
Refrigerator	300	110-120	2 No. 12	20 Amp.
Home Freezer	350	110-120	2 No. 12	20 Amp.
AutomaticWasher	1200	110-120	2 No. 12	20 Amp.
Automatic Dryer	5000	110/240	3 No. 10	30 Amp.
Rotary Ironer	1650	110-120	2 No. 12	20 Amp.
Water Heater	3000	(Check with utility Co.)		
Power Workshop	1500	110-120	2 No. 12	20 Amp.
Television	300	110-120	2 No. 12	20 Amp.
¾ hp Air Conditioner	1200	110-120	2 No. 12	20 Amp.
Heating Plant	600	110-120	2 No. 12	15-20 Amp.

Specifications and recommendations given for wiring in this booklet are for typical installations and are in compliance with the minimum safety standards established by the National Electrical Code. However, adequate and sufficient circuits for a particular building are a matter of selection by the owner. Each installation must comply with local ordinances and building codes as well as National or R.E.A. (Rural Electrification Administration) requirements. Before going ahead the owner should familiarize himself with all wiring requirements.



TODAY'S FARMS DEPEND ON MODERN

ELECTRICITY COSTS LESS . . . HELPS YOU MAKE A BETTER LIVING EASIER

Few farmers today can afford to overlook the many cost-cutting, time- and labor-saving advantages that electric power offers. Countless chores such as pumping water, shelling corn, milking, etc. are performed by electricity for little as a few cents a day. It can operate many pieces of equipment unattended, thereby relieving the operator for other work. Adequate electric lighting, properly placed, can stretch the working day of the farmer and help eliminate accidents.

Safe, dependable, low in cost—the more electricity that is used, the less it costs per unit or kilowatt hour, since rate schedules are always based on a sliding scale. For as little as 10c a day, electricity can do the mechanical work of a hired hand working all day!

GENERAL EXPLANATION OF ELECTRICAL DISTRIBUTION ON A FARM. From the layout above, it will be easily seen how current is transmitted to a typical farm and distributed to the various buildings. In general, the utility company brings its power line (commonly referred to as the high line) to a point where it is connected to a distribution transformer which taps off the proper voltage needed for farm use. From this point, secondary lines conduct the current to a yard pole. Here, the incoming lines are fed through a meter which measures the current consumed. Although meter can be mounted on the outside or inside of a building, modern farm practice is to place it on a yard pole which can be more centrally located. From the meter, the current is often fed into a weather-proof disconnect switch—either fused or circuit breaker type.

Individual feed circuits extend from the yard pole to all heavy current-consuming buildings. Garages, poultry houses, sheds and other buildings requiring less demand, are fed from the nearest main buildings. See details on Pages 28 to 30. Consult your local power company or R.E.A. cooperative before starting your yard-pole installation.

PLANNING THE INTERIOR WIRING SYSTEM

Before the main service (meter and yard pole assembly) and exterior wiring can be planned, the needs of individual buildings must be determined. Hence, interior wiring for farm buildings should be planned first to assure:

1) proper type and number of switches, convenience, lighting and special outlets located in right places;
2) enough branch and individual equipment circuits to handle present and foreseeable future needs;
3) service entrance equipment (where feed wires enter building and branch or individual circuits are fused and controlled) with capacity to handle extra needs.

By doing the job yourself, you will effect a considerable saving, but it pays to plan ahead—whether you are wiring new or rewiring old buildings. The added cost, in terms of time and labor invested, of installing adequate wiring at the time of initial installation is only a fraction of the cost of rewiring at a later date. Any increase needed later in the wiring system means doing the job twice. Material is wasted, and labor is used first to take out old wiring, secondly to put in new wire. Make use of the handy Planning Chart enclosed with this booklet.

WIRING FOR EFFICIENT OPERATION

PLANNING THE EXTERIOR WIRING SYSTEM

Adequate planning and selection of wire and equipment for supplying power to buildings is just as important as for interior wiring. Here, again, it is good business to anticipate future needs by installing equipment of ample size to handle heavier loads at a later date. Remember, the amount of time and labor invested is the same, regardless of the size wires used.

The yard pole wire assembly must be big enough to handle total number of amperes required for the entire farm. It should be located as close as possible to the buildings where the greatest amount of power will be used in the years ahead. This means that the pole will be located so that the largest size wires used will be the shortest, while longer but smaller and less expensive wires will be run to buildings where less power is needed.

In deciding on size wire needed for runs to each building, besides allowing extra capacity for future loads, these factors should be considered:

1) it must carry the ampere load of the building;
2) it must carry the electrical load without excessive voltage drop (explained on Page 9);
3) it must be strong enough, considering length of span, to withstand weather elements: cold, ice, wind, etc.

At each building served direct from yard pole, there must be a service entrance installation. It should be of large enough capacity to handle the electric load first installed, as well as any foreseeable load.

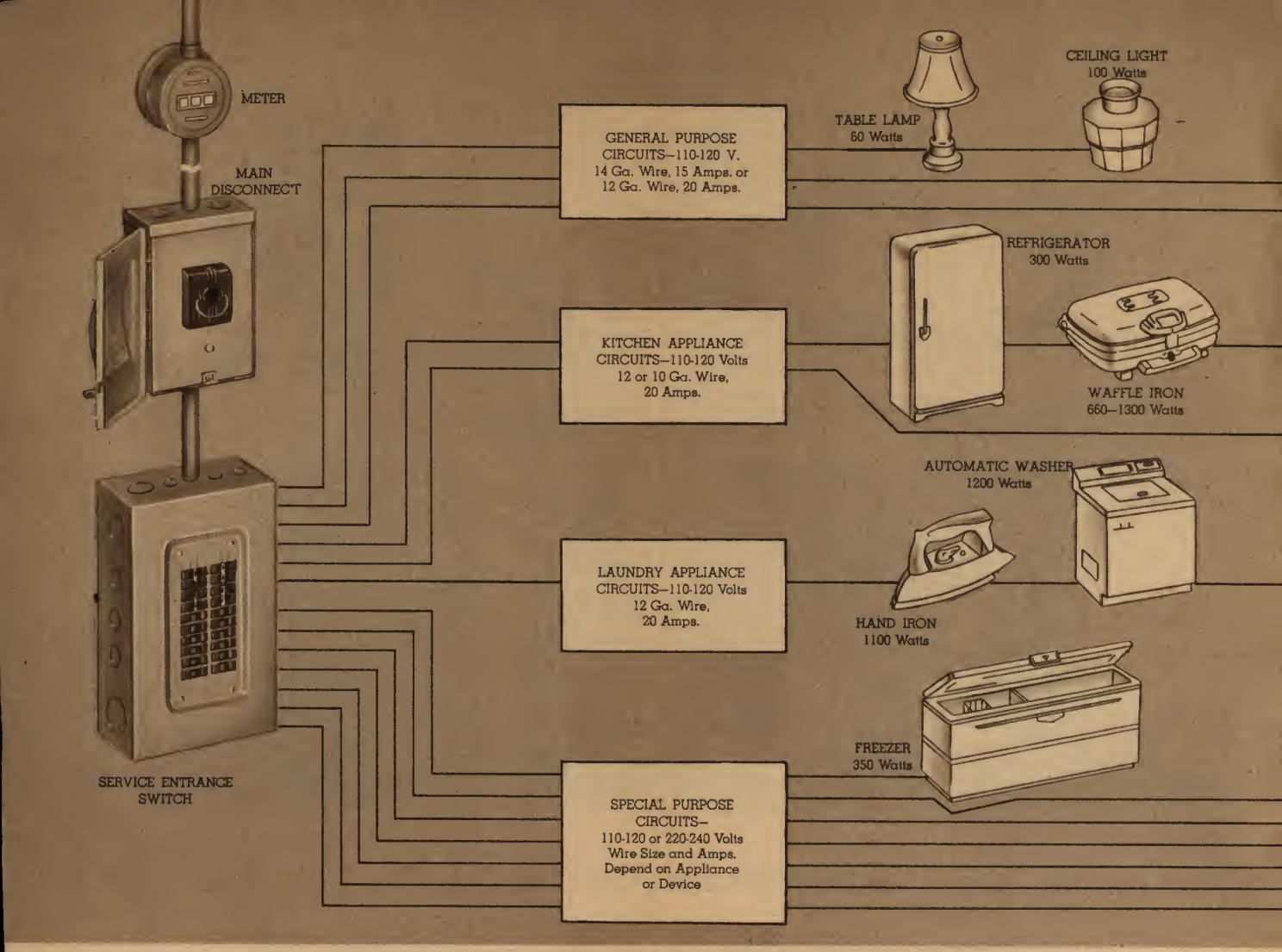
WIRE NOW FOR FUTURE EQUIPMENT

With the introduction of highly specialized implements and numerous productive tools, the modern farmer has become less and less dependent upon costly hand labor while his output, per man hour, continues to increase. But to remain competitive, he must rely even more upon the cheapest efficient power he can get—electricity. As the use of one electrical servant leads to another, it is imperative for him to look ahead—5 to 10 years from now. Thought should be given to electrical equipment that will be available to serve him best in the future. Be sure your plans allow for ample use of electric motors. See Page 25 for further information on use of motors.

The table below gives requirements of typical farm equipment you may now have or want to install later.

Type of Equipment	Typical Wattage	No. of Wires and Voltage	Recommended Fuse or Breaker
Cream Separator	300-800	2 110-120	20 amp.
Water Pump	300-2000	2 110-120	20 amp.
Milking Machine	400-1500	2 110-120	20 amp.
Milk Cooler	400-750	2 110-120	20 amp.
Poultry Brooder	1000-2000	2 110-120	20 amp.
Arc Welder (180 amp)	7300	3 220-240	40-50 amp.
Feed Mixer (2 HP)	3000-5000	3 220-240	20 amp.
Electric Motor (3 HP)	4000-6000	3 220-240	30 amp.
Hammermill (5 HP)	6500-10000	3 220-240	30-40 amp.

Farm wiring systems, in general, are similar to those installed elsewhere in the city. Fundamental wiring installations dealt with in this booklet apply to farm as well as city needs. Specific farm wiring problems such as grounding, yard pole wiring, are treated separately on Pages 28, 29, 30—underground wiring on Page 27.



PLAN YOUR WIRING TO ACCOMODATE

COMPONENTS OF HOME WIRING SYSTEM

Your home's electrical system begins at the point where the utility company's power line is connected to your house or yard pole. You supply all the material except the meter and meter socket which are usually furnished by the utility company.

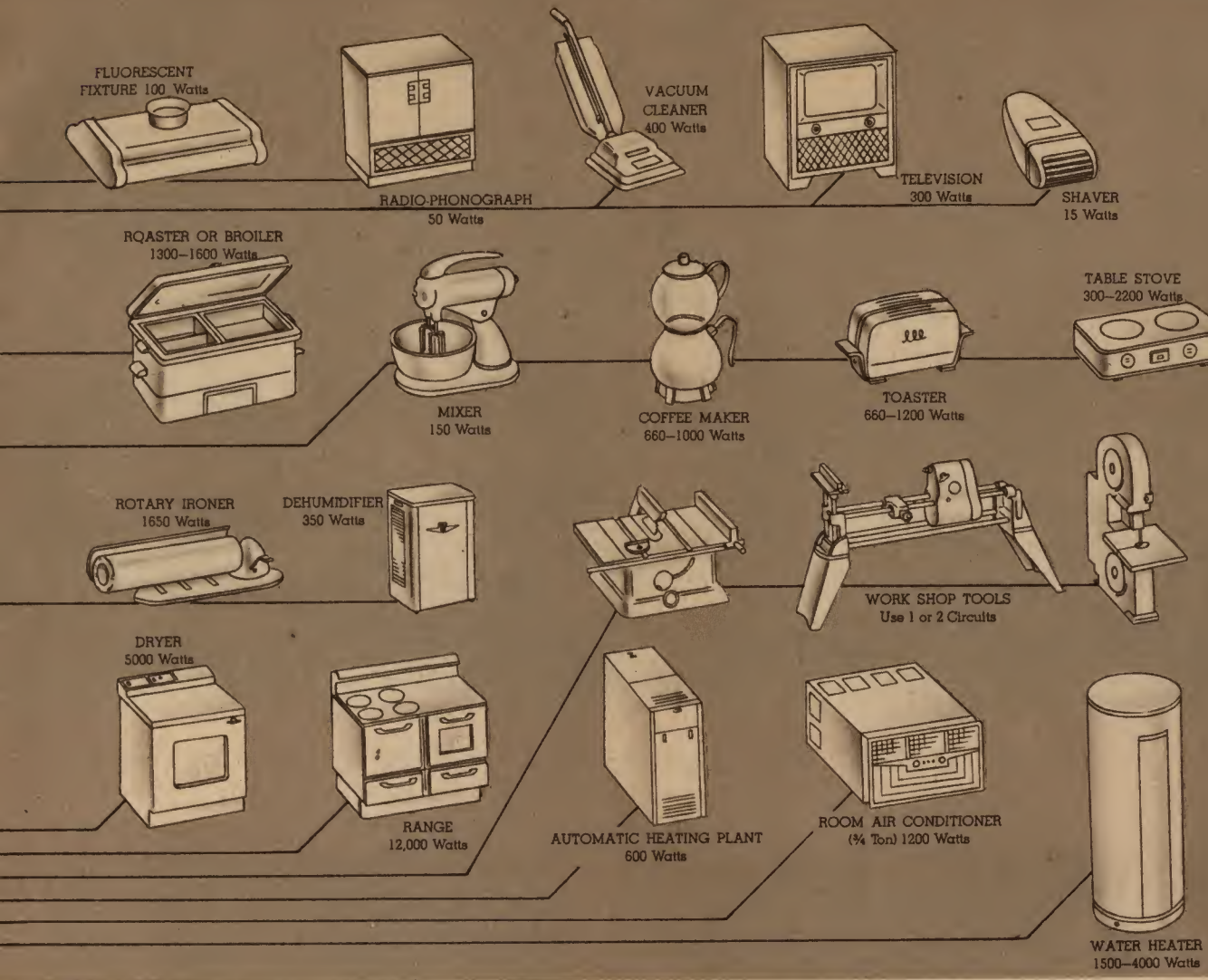
Beginning with the service head, the service entrance wires are fed through the meter and brought into the house (usually through the basement—illustrated on Pages 10 and 11) and terminate in the service entrance switch cabinet. Here is where the main disconnect switch and branch circuit fuses or circuit breakers (pictured above) are located. From this junction point, branch circuits transmit the current to various rooms in the house.

The main switch is designed for cutting off all power to the house if desired. Main fuses control the *total* load that may be connected at one time. Branch fuses or circuit breakers protect branch circuits from overloads. If a circuit is overloaded, a metal link in the fuse melts and cuts off current flow before wires become dangerously overheated. The circuit breaker performs a similar task by jumping to "trip" position automatically when circuit is overloaded—see Page 12. The 220-240 volt circuits serving an electric range, water heater etc. are protected by two cartridge type fuses or one double-pole circuit breaker.

PLAN ADEQUATE SERVICE ENTRANCE

Plan now to avoid a service entrance "bottleneck" later. All present and future use of electricity in your home is governed by the capacity of its service entrance equipment (wires and service entrance switch). If either the wires or the service entrance switch is too small, the addition of a single appliance may necessitate replacement of one or both. The capacity of the service entrance switch should match that of the entrance wires.

Often times just because "3-wire" entrance equipment has been installed, the wiring is assumed "adequate." This, of course, is a mistake. It may handle one or two major appliances such as a range or water heater, but any additional appliances may require a larger size service entrance. The capacity of the service entrance (wire, main switch and fuses) is *always* the controlling factor. So if, for any reason, you are unable to make your entire electric system complete as desired at the beginning, be sure, at least, to install an adequate service entrance. Branch circuits for handling additional appliances can be installed later. Remember that no matter how large the service entrance is, no more current comes into your home than your electrical needs require; you never pay for more electricity than you actually use. And by allowing for future expansion, you save money in the long run.



PRESENT AND FUTURE ELECTRICAL NEEDS

CALCULATING SERVICE NEEDS

You should first estimate the square foot floor area of your home. (Multiply length times width of all finished areas of first floor, second floor including spaces in attic or basement which are finished or will be used later.) Do not include garage or open porches. Using this figure as a guide, select recommended capacity service entrance wires and equipment for your home from table below.

Sq. Ft. Area Up To	No. Entrance Wires, Size & Amperage	Circuit Breaker (Amps)	Main Switch (Amps)	Main Fuse (Amps)	Reserve Power (Watts)
1000	3 #6, 70	70	100	70	4700
1500	3 #4, 85	90	100	90	6000
3000	3 #2, 95	100	100	100	6000

The 3-wire (110-120/220-240 volt) entrances listed in table above provide for adequate normal lighting, plug-in appliances including an ironer, roaster, refrigerator, clothes drier, a range and water heater plus reserve power (right-hand column) for additional branch circuits to handle major appliances which may be bought in the future. If wattages specified are to be obviously exceeded, select the next larger size service entrance. Load chart on Page 3 covers wattages of typical household appliances.

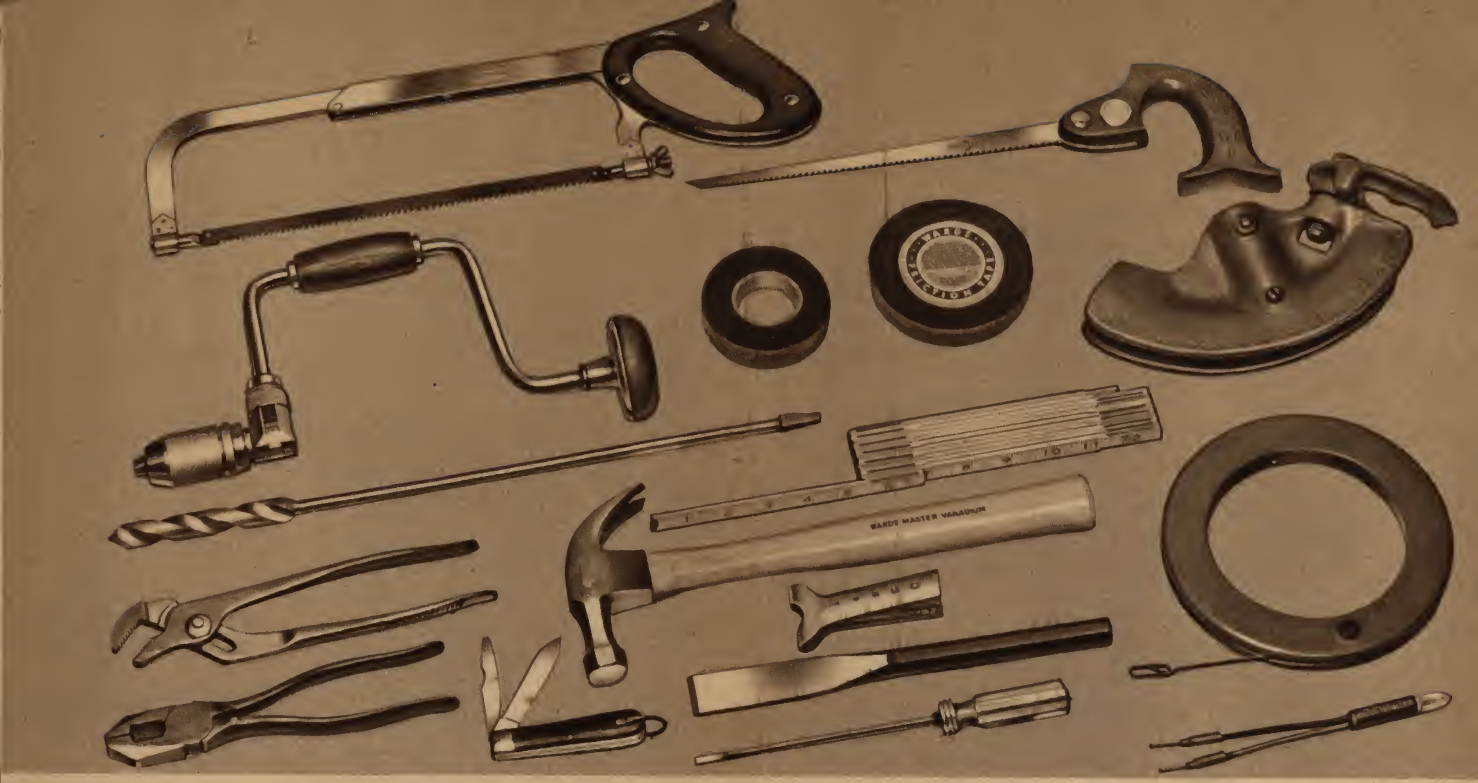
PLAN ENOUGH BRANCH CIRCUITS

Modern house circuits are divided into the following three general classes according to their use:

GENERAL PURPOSE CIRCUITS—They serve lights all over the house and convenience outlets everywhere except in the kitchen, laundry and dining areas. Wired with #14 wire and fused at 15 amperes in most older homes—this circuit handles up to 1750 watts. For present-day systems, we recommend #12 wire fused at 20 amperes to handle up to 2300 watts. Plan one of these circuits for each 500 ft. of floor area, with outlets divided evenly among circuits on different floors to avoid complete darkness if fuse blows.

APPLIANCE CIRCUITS—Only for convenience outlets, *independent of lighting fixtures,* in the kitchen, laundry and dining areas to serve refrigerator, washing machine and portable high-wattage appliances. At least one of these circuits is required; we recommend three—two for kitchen appliances and one for laundry room or basement. No. 12 wire fused at 20 amps is required; #10 wire is recommended.

INDIVIDUAL CIRCUITS—For serving one piece of major electrical equipment such as a clothes drier, range, water heater, air conditioner, etc. Size wire and types of fuses or circuit breakers needed depend on rating of appliance.



IT'S EASY TO INSTALL YOUR OWN WIRING

HOW TO START YOUR WIRING JOB

Most of the tools necessary to do a good wiring job are pictured above. If you are familiar with their use and if you plan your job carefully before starting, you should have no difficulty in installing your own wiring sc that it will conform to local and National Electrical Codes. For major work such as installing service entrance equipment, discuss your plans with local utility Co. or REA.

With normal care, and by doing the job yourself, you will be amply rewarded by the money saved and the personal satisfaction you will get from a job well done.

NOTICE—*Wards recommend that you always disconnect all current supply before starting any electrical work.*

YOUR FIRST STEP is to prepare a sketch (use planning chart furnished with this booklet) showing exactly what type of installation you want and where.

YOUR NEXT STEP IS TO FIND OUT IF A PERMIT IS NEEDED. Most localities have no regulations prohibiting a home owner from wiring his own premises. Some cities may, however, require a wiring permit before the job is started. Before applying for a permit, be sure to familiarize yourself thoroughly with applicable code regulations and have a complete understanding of the job at hand by studying this booklet. When permit is issued you will be asked to advise when job is completed so it can be inspected. If your wiring conforms to code regulations, the inspector will approve the job and the power company will supply you with electricity.

FOR MORE DETAILED WIRING INFORMATION order "Wiring Simplified" booklet from Wards General Catalog. Over 125 pages cover all phases of farm and home wiring.

CODES . . . UNDERWRITERS' LABORATORY

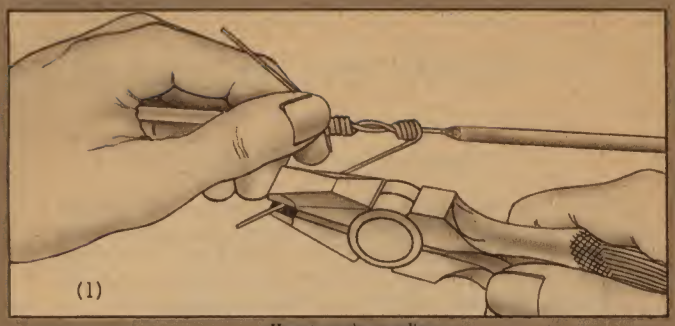
In recent years, electricity has become an essential part of our daily living. When properly controlled, it serves us cheaply and efficiently in thousands of ways.

Definite standards have been set up to cover both the manufacture and installation of electrical equipment. Today, no manufacturer makes equipment to suit his own standards—he makes it to conform with safety standards set up by codes and associations. Likewise, no workman should install wiring to suit his fashion but only according to code requirements. Thus, standards of adequate safety and uniformity are assured in all localities.

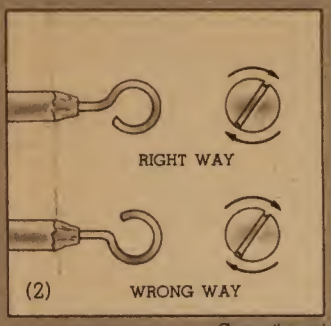
THE NATIONAL ELECTRICAL CODE regulations are simply a set of rules which outline wiring standards that have been found safe and sensible over a period of years. The provisions of the code are intended only for *minimum* safety standards and must be followed on all jobs. Get a copy of code regulations from your local utility Co.

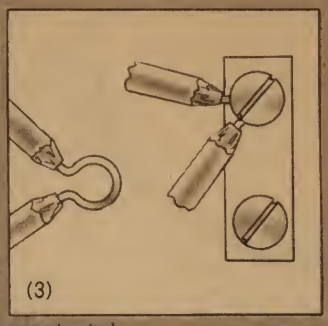
LOCAL REGULATIONS. Often local ordinances or building codes supplement and take precedence over the National Electric Code. The use of certain generally accepted materials or practices may be limited in some areas. Be sure the materials such as armored cable, non-metallic cable, etc. are approved by your local codes.

UNDERWRITERS' LABORATORIES. Many communities have ordinances requiring the use of only wiring equipment listed (usually tagged or stamped for easy identification) by Underwriters' Laboratories. This is a nationally accepted organization which tests wiring materials and devices for minimum standards of safety and quality (equipment is approved only for the purpose it is intended). It will pay you to use better quality UL Approved materials. Shop from Wards catalogs or retail stores for highest quality merchandise. All Wards electrical supplies are UL approved and meet REA specifications where required. See Page 31 for illustrations of Wards special purpose wiring aids.

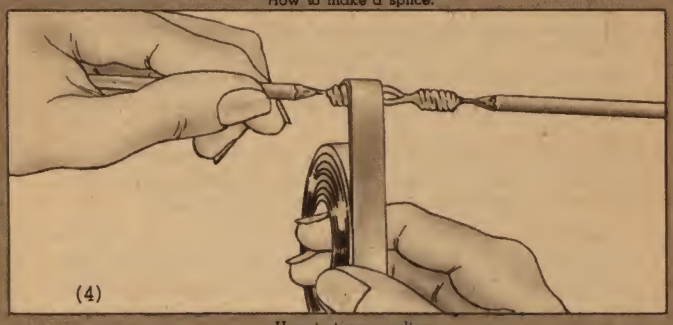


How to make a splice.



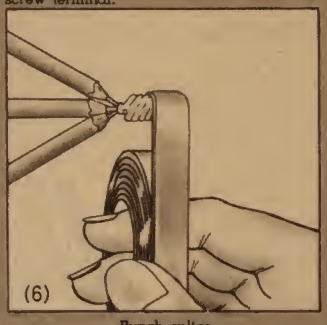


Connections at a screw terminal.



How to tape a splice.

Use of solderless connector



Bunch splice.

BY FOLLOWING THESE INSTRUCTIONS

CUTTING, SPLICING, CONNECTING WIRES

The need for splicing and terminating wires occurs in every wiring job. A good electrical connection must meet three requirements: (1) wires must be cleaned free of insulating materials; (2) connections must be secure; (3) splices must be covered with tape so that wire is as well insulated as it was before insulation was removed.

REMOVING INSULATION—to avoid nicking wire, always cut insulation at a slant as when sharpening a pencil.

WIRING SCREW TERMINALS—Expose about 1 inch of wire for making connections. Bend end of wire into a loop and insert under screw so that tightening tends to close loop (fig. 2). Connection for 1 continuous wire shown at fig. 3.

MAKING SPLICES—a spliced wire must be as good a conductor as an unbroken piece of wire. Where there is a strain on the wire, the splice (fig. 1) must be as mechanically strong as a continuous wire. Remove about 3 inches of insulation, cross wires about 1 inch from insulation and make about 6 to 8 tight, closely-wound turns. Then apply a rosin-base solder and tape.

If there will be no strain on the wire, as in an outlet box, a solderless connector may be used, without solder or tape. Simply screw the connector over wires—fig. (5).

In some cases, you may want to join more than 2 wires (see fig. 6). For example at a ceiling outlet where a number of wires are joined (and no strain is involved), you may twist wires together, solder and tape, or simply screw on a larger size solderless connector—see (B) at right.

SOLDERING—Clean wire of insulation taking care not to remove tin coating if any. Apply heat to wire at joint (not to solder) until wire is hot enough to melt solder.

TAPING—first wrap joints with rubber tape, then cover with friction tape. Or cover joint in one operation with newer type plastic tape as shown in (fig. 4).

ELECTRICAL TERMS YOU SHOULD KNOW

VOLT—the unit used for measuring electrical pressure. Corresponds to pounds pressure in a water system.

AMPERE—the unit used for measuring electrical rate of flow—corresponds to gallons of water per minute.

WATTS—the unit of measure for electrical power. Volts times amperes equals watts or energy consumed. 1 watt used for 1 hour is 1 watt hour—1000 watt hours equals 1 kilowatt hour. Since power is measured and paid for in kilowatt hours, it's easy to measure operational cost of any electrical device. Simply multiply the watt rating of device by the hours used, convert to kilowatts (divide by 1000) and multiply by cost per KWH shown on your electric bill. For example, if electricity cost 6c per KWH, a 1000 watt iron used 2 hours would cost 12c.

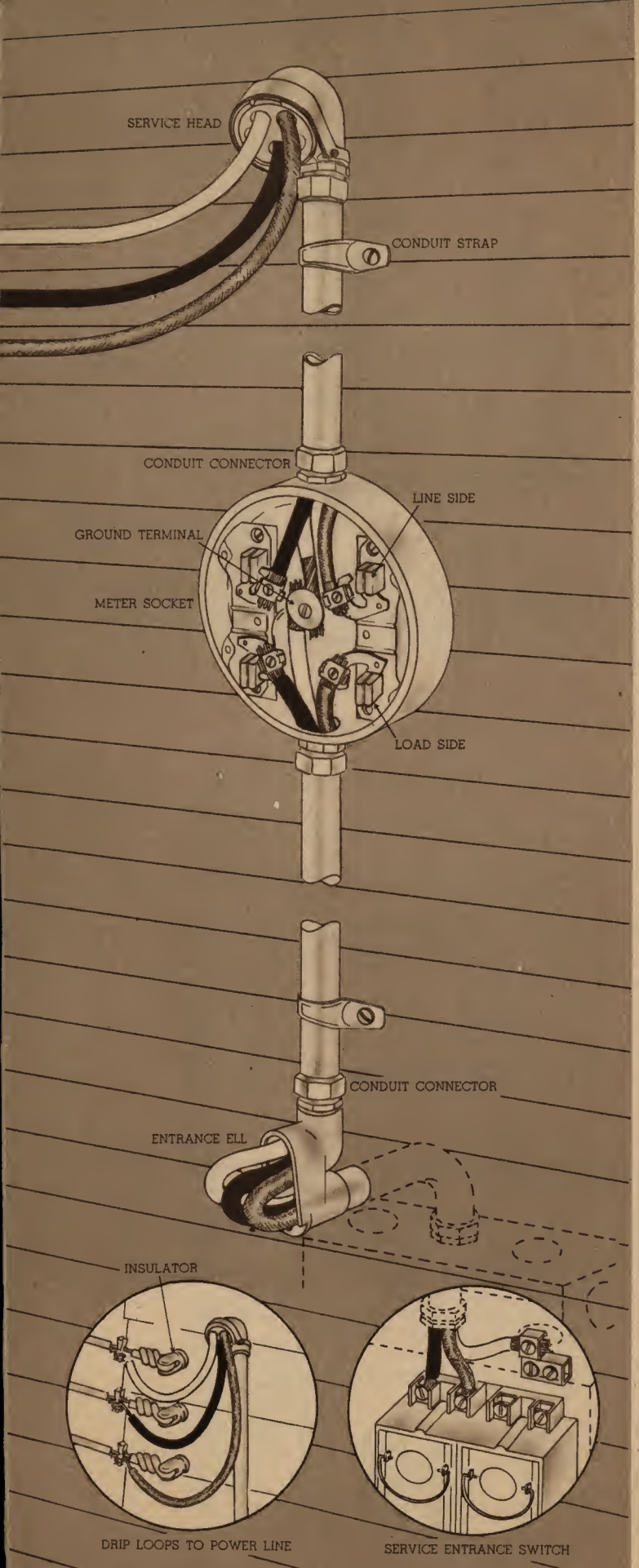
"HOT" WIRES—power carrying wires (usually black or red).

NEUTRAL OR GROUNDED WIRES connect electrical system to earth as a safety precaution (always white or bare).

VOLTAGE DROP—is a loss of electrical current in the form of heat—a loss which you pay for in your electric bill. It is caused by overloading wires or by using excessive spans of improper size wire. Just as in a water system, a long, small-size pipe will cause an excessive drop in pressure, so is there a corresponding loss to heat in an inadequate wiring system. Heat where you don't want it is a waste.

SAVE TIME WITH SOLDERLESS CONNECTORS

SCREW TYPE (A), (B) for small size wires. Use (C) and SPLIT BOLT type (D) for heavy gauge service entrance wires.



How to install

USING STEEL CONDUIT

It is most practical today to install a 3-wire service entrance (read previous pages). The meter is supplied by the utility company, and usually they will furnish and install all wiring leading into meter, including the meter socket. All wiring beyond the meter is your responsibility.

Whether you use rigid or thin-wall conduit or service entrance cable depends on local regulations. Consult your local Utility Co. before starting the job; they will help determine exactly where the service entrance should enter your building, or will advise if a yard pole is needed.

CONDUIT SIZE—after you have calculated the proper size entrance wires for your needs (see recommendations on Page 7), choose from the following conduit sizes:

Use ¾-in. conduit with three No. 8 wires, 1-in. conduit with three No. 6 wires, 1¼-in. conduit with either three No. 4 or three No. 2 wires for runs not exceeding 50 ft.

INSTALLATION—the incoming power lines are anchored to the building by service insulators. Install insulators as high as practical—the National Electrical Code requires a clearance of at least 10 ft. above sidewalks and 18 ft. above driveways. On farms, be sure to provide substantial clearance for loaded wagons or trucks.

The service head must be attached to building above the topmost insulator (see picture below) to prevent rain from entering system. Connect thin-wall conduit as shown, at left, using a metal strap every 4 ft. to fasten to building. Fasten conduit to meter socket with weatherproof connectors. With rigid conduit, standard pipe threads are used.

At the point where conduit is to enter house, use an entrance ell with a removable cover. With cover removed, it will be a simple matter to pull wires through. Use an ell with threaded openings to correspond with size conduit being used. Fasten conduit to ell with adaptors. Conduit should be securely anchored to all parts of service entrance assembly to make both a strong mechanical joint and a good grounding provision (See opposite page).

Install service entrance switch inside of building within one foot of place where conduit passes through wall.

INSERTING WIRES. After the conduit is completely installed, it will be an easy job to pull the wires through. They must be continuous and unspliced. Use one white, one black and one red wire. Building wire type "TW", "R" or "RHRW" is generally used. The white wire is always the neutral or ground wire. The black and red wires give 220 volts, while the white with black or the white with red give 110 volts.

Where short lengths are involved, no fish tape will be necessary. Simply push wires into conduit at top and down to the meter socket. From there, push other lengths into conduit down through entrance ell and to the inside of house. If run is long or has bends in it, push fish wire (or clothes line type wire) into the conduit, attach wires, and pull them through. Connect wires to proper terminals on meter socket as shown at left. Be sure to allow plenty of length, *at least a 3-ft. projection outside of entrance head,* for drip loop connections to incoming power line.

CONNECTIONS AT ENTRANCE SWITCH—connect the black and the red incoming wires to the heavy terminals of entrance switch. The white (bare in the case of cable) neutral or ground wire is attached to the ground strap.

SERVICE ENTRANCE

USING SERVICE ENTRANCE CABLE

Lower in cost and generally easier to handle than conduit, service entrance cable is most frequently used for service entrance installations. Its flexible construction permits easier handling around corners, bends, etc. Use of armored or unarmored type depends on your local code. In selecting cable size, be sure to allow for future power requirements.

HOW TO INSTALL—the installation of service entrance cable does not differ greatly from the procedure for installing conduit. The service head must be fastened to building at least 10 feet above ground. (Install the service head so that it projects above the topmost insulator to prevent rain from entering system—see illustration of drip loops on opposite page.) See opposite page also for power line clearance and other general information.

Cut a length of service cable long enough to reach from meter socket to entrance head, plus about 3 feet extra to allow for drip connections to power line. Then strip the outer cover from end of cable so that lead wires will extend at least 3 ft. outside of the service entrance head. Note that the ground wire of service entrance cable consists of several uninsulated wires spirally wound around two insulated wires. Simply bunch together and twist them to form third wire, and insert all 3 wires through service head.

Secure cable to building every 2 feet with metal straps. Anchor to meter socket with weatherproof connectors as pictured at right. From meter, run cable down wall to hole drilled through side of building and connect to the service entrance switch. Locate switch within 1 foot of where cable passes through wall. Wire connections at the entrance switch are same as for conduit—see opposite page.

Where the service entrance cable enters building, install a sill plate and pack tightly with weatherproof compound (usually furnished with sill plate) to prevent rain from following cable into building.

GROUNDING THE SERVICE ENTRANCE

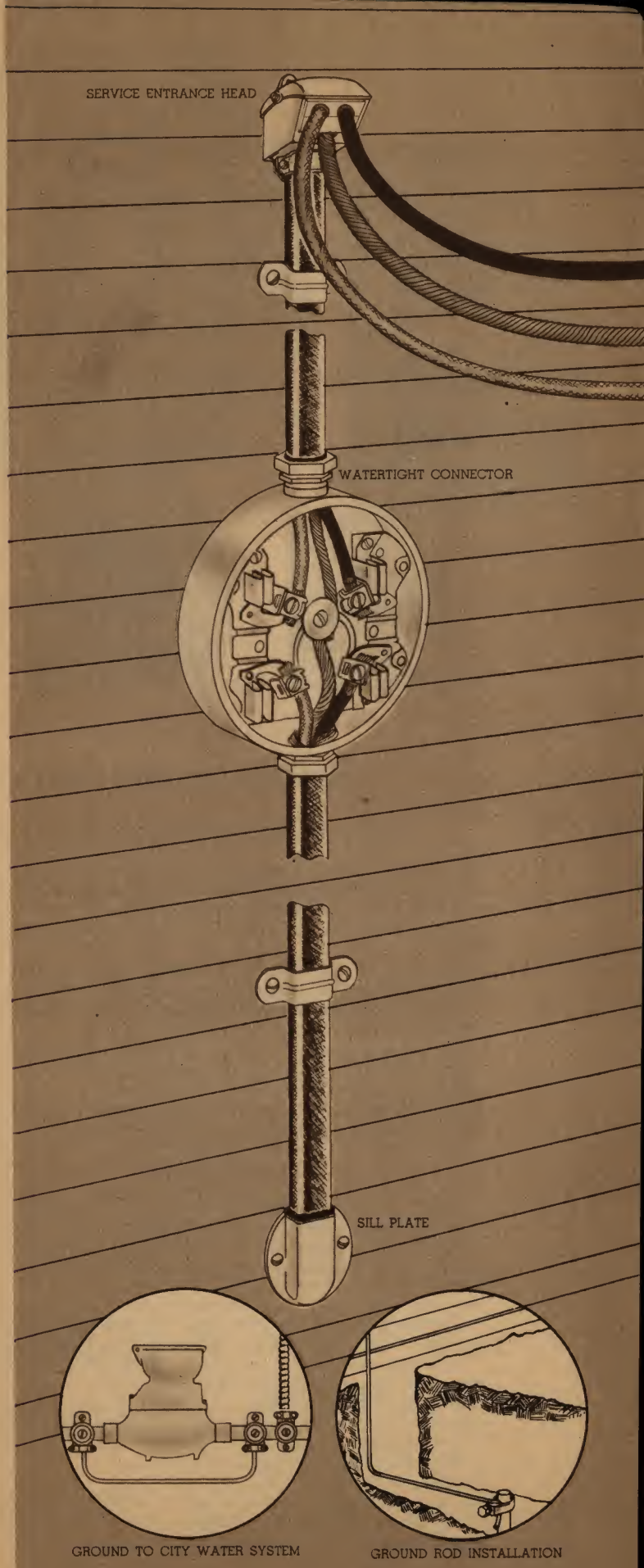
The neutral wire of every electrical system is required to be grounded at some point . . . that is, it must be in direct contact with the earth. Grounding reduces effects of accidental high potentials and lightning.

For city type underground water systems simply run a wire from the neutral bar of the service entrance switch to a cold water pipe and anchor securely with ground connectors. If feasible, make connections to pipe on street side of water meter. Otherwise, connect to nearest point on pipe and install a jumper ground wire around the water meter by using two ground connectors.

GROUNDING FOR FARMS. If a city type water system is not available, an "artificial" ground must be installed. The ground wire is tapped off the neutral overhead wire (at drip loop), brought down side of building or yard pole and attached to a driven ground rod with a ground clamp.

The rod is usually copper clad steel and must be at least ½ in. in diameter. Galvanized water pipe, if acceptable to local code, must be at least ¾ in. diameter. Locate rod 2 ft. from building and drive at least 8 ft. into earth. Check local code provisions.

GROUND WIRE SIZE. Usually No. 6 or 4 uninsulated wire is used. If No. 8 wire is used, it must be armored or run through conduit. Keep runs short as possible.



SELECTING THE SERVICE SWITCH

PURPOSE OF THE ENTRANCE SWITCH

The service entrance switch provides overload protection not only for branch circuits but also is a means of disconnecting all current from the power lines as a safety measure when making changes or repairs on the wiring system.

Two types of service entrance switches are in general use. The most common and least expensive is the fuse type. The other is the fuseless or circuit-breaker type, which is the most convenient to use.

Each type is rated in amperes and must be of sufficient capacity to accommodate the maximum amount of current which will be used at one time. When selecting a switch, consider both your present and future electrical needs. Wards recommend the 100 ampere capacity switch.

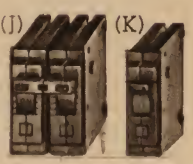
FUSE TYPE EQUIPMENT

Modern combination fuse type entrance switches eliminate the need for separate safety switches for individual 220-240 volt appliances. Two cartridge type fuses for protecting range, water heater or dryer are mounted on a removable block—see (A), (B), (C) above. This block can be easily pulled out of the entrance switch and fuses replaced while block is in your hand—the circuit remaining dead. Plug type fuses protect 110-120 volt circuits.

In addition to "pull-out" blocks for 220-240 V appliances, some types of entrance equipment contain a main "pull-out", switch (C) above, for shutting off all current entering the service entrance switch. This main disconnect is fused to the total amperage capacity of the box.

Generally, the main disconnect and the branch circuit fuses are in the same cabinet. In some cases, however, local code or building needs may require a separate main disconnect switch installation. Figure (D) shows cabinet housing plug-type fuses only.

CIRCUIT BREAKERS



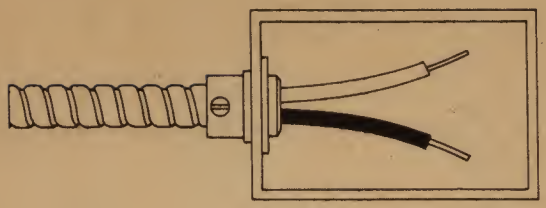
Circuit breaker entrance switches (E), (F), (G), (H) can be used in place of fused equipment. Fuse blowouts caused by temporary overloads are eliminated since when a circuit is overloaded or a short occurs, the breaker will trip automatically, stopping the flow of electricity through that circuit. To restore service, simply correct the fault and flick the handle to "on" position. Circuit breakers take temporary overloads such as the starting of a washing machine, refrigerator, etc., without tripping. To disconnect all power, flick handles on all circuits to "off" position, unless a separate disconnect is installed between power line and entrance switch as shown on Page 6.

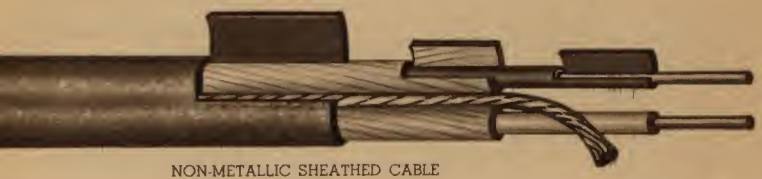
Each 220-240 volt circuit requires a double pole breaker (picture J above); each 110-120 volt circuit requires a single pole breaker (picture K). No current carrying parts are exposed in circuit breaker assemblies.

CIRCUIT BREAKER EQUIPMENT IS AVAILABLE TWO WAYS. (1) It can be purchased "ready-made" complete with various combination of single and double pole breakers to suit many installations. Or (2) you can make up your own "custom-designed" assembly by ordering blank circuit breaker boxes, then ordering the particular single or double pole breakers separately as you need them.

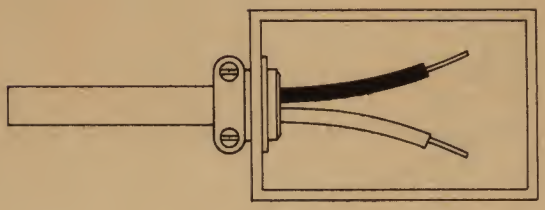
WHEN A FUSE BLOWS OR A CIRCUIT BREAKER TRIPS your first step should be to find out why. Either something connected to the circuit is defective, or too many devices are in use on the circuit at one time. If a fuse blows when a motor device is turned on (motors draw heavy current when starting) a time lag fuse may solve the problem. But never attempt to remedy current interruptions by substituting oversize fuses or breakers for the size wire involved.

ARMORED CABLE

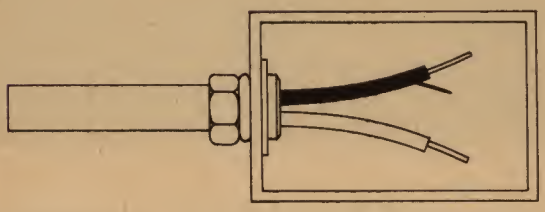




NON-METALLIC SHEATHED CABLE



THIN-WALL CONDUIT



Basic types of interior wiring

Three basic types of approved interior wiring systems are in general use for modern residential and farm wiring: (1) flexible armored cable, commonly known as "BX", (2) non-metallic cable or "romex" and (3) thin-wall conduit. Selection of one of these types depends on local regulations and the type of structure to be wired; follow local custom. Newer type plastic non-metallic cable (see fig. 3, page 14) is rapidly coming into favor, especially on farmsteads. Other less commonly used interior wiring systems include knob and tube, rigid conduit and "greenfield"; see Page 17 for brief descriptions of each.

FLEXIBLE ARMORED CABLE (BX) consists of 2 (or 3) insulated wires wrapped in spiral layers of tough paper and protected by a galvanized steel casing. It is recommended for indoor use in dry localities, especially where a city ground system is available (do not use out-of-doors or underground). Easy to install and acceptable in most localities, armored cable is particularly suitable for house wiring—it affords a continuous ground and good mechanical protection. Use it for both exposed and concealed work—along walls, ceilings, etc., or in hollow spaces of walls, floors and ceilings. May also be imbedded in plaster or other masonry except in damp locations. Because of its flexible, easy-to-handle properties, armored cable is frequently used for extensions of conduit systems on rewiring jobs.

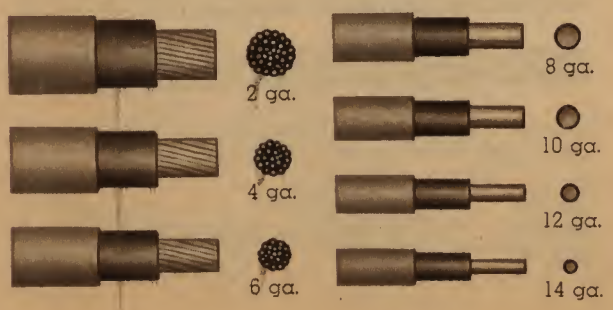
NON-METALLIC SHEATHED CABLE (Romex) consists of 2 (or 3) insulated wires, each wrapped with spiral paper tape, over which is applied a heavy fabric jacket, chemically treated to resist fire, moisture and acid vapors. It is recommended for indoor use in homes, garages and other outbuildings. Do not use out-of-doors, underground or in masonry. Use it for both surface and concealed work. Low in cost, lightweight and easy to install, it is the most commonly used cable. New PLASTIC COVERED NON-METALLIC CABLE is unusually tough and versatile. Thermoplastic insulated and jacketed, it is highly resistant to mechanical damage, acids, moisture, and rot. It is especially suitable for damp locations—excellent for wiring barns. It can be installed in brick or masonry walls. Ideal for indoors or out, in wet, dry or corrosive locations or in underground feeder runs.

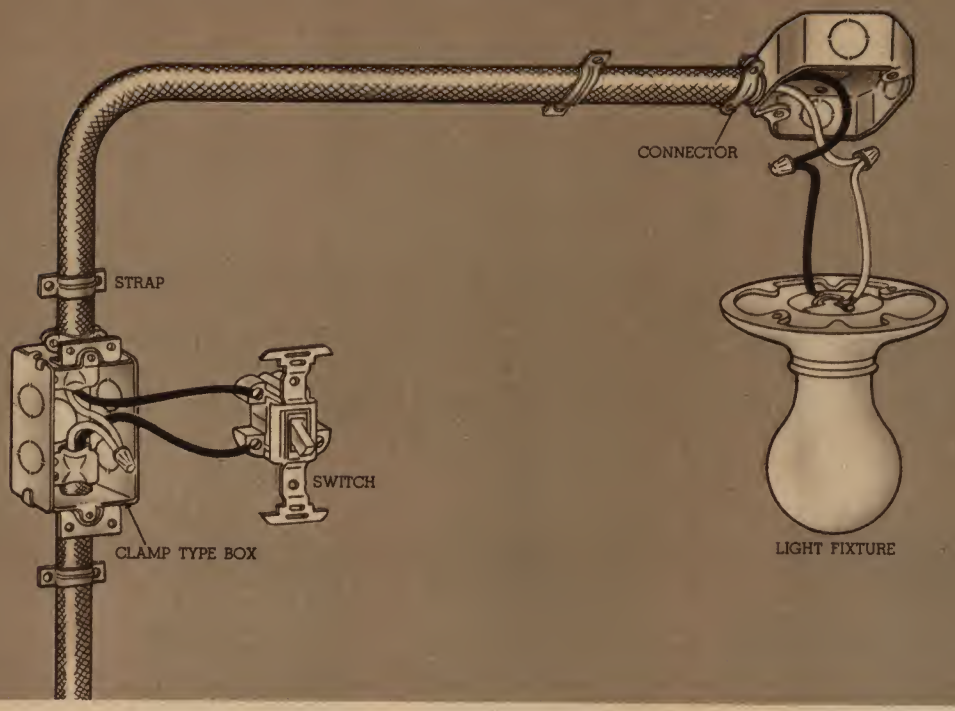
THIN-WALL CONDUIT is a commonly accepted material for ordinary household wiring. It affords greater protection to wires than other types and permits grounding of entire system. In many cities, conduit is the required method of wiring for new buildings.

Thin-wall conduit looks much like water pipe but is lighter weight and is easy to cut or bend. Joints and connections are made with special threadless fittings. Insulated wires are drawn through after conduit is installed. Use for both concealed or exposed work, indoors or out, in wet or dry locations and in masonry except in cinder concrete.

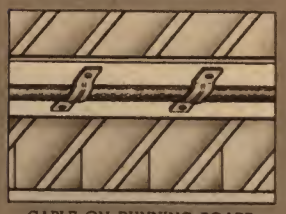
ACTUAL WIRE SIZE OF COPPER CONDUCTORS

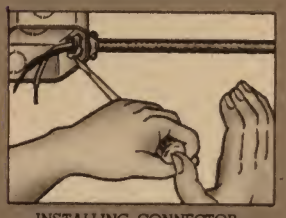
Correct wire size in electric wiring is important—see Voltage Drop explanation on Page 9. Notice that the larger the number, the smaller the diameter of the wire.






SLITTING CABLE


CABLE ON RUNNING BOARD


INSTALLING CONNECTOR

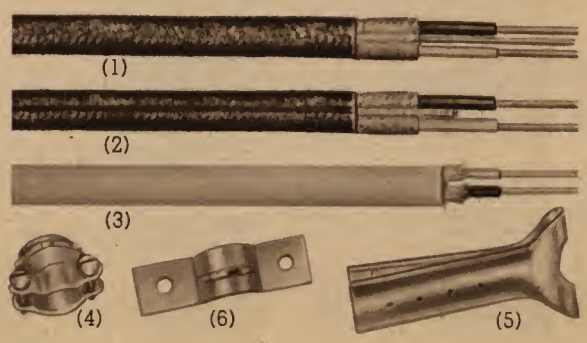
How to install non-metallic cable

Non-metallic sheathed cable (Romex) costs less than other kinds of cable in common use, is light in weight and very simple to install—no special tools are needed. For indoor use with either steel or bakelite boxes.

REMOVING OUTER COVER. Remove about 6 to 8 inches of the outer cover by slitting the braid with a knife or the handy cable ripper (fig. (5) below). Take care to cut only the outer braid so that the inner insulation isn't damaged.

CONNECTING TO OUTLET BOXES. Fasten connector, (fig.(4) below) to outside covering of cable. Then insert cable into knockout hole of box and anchor securely to box by screwing locknut of connector tightly against box from the inside as shown above. If using boxes with built-in clamps, connectors aren't needed—simply insert cable into clamp opening and tighten clamp with a screwdriver.

NON-METALLIC CABLE WITH GROUND WIRE (fig. 1) is required in some areas. Use same way as regular cable (fig. 2) but connect bare ground wire solidly to metal outlet boxes (under locknut or box clamp). NEW ACID RESISTANT PLASTIC CABLE (fig. 3) can be used indoors or out. It is ideal for use where moisture, ice, fungus, or ammonia-laden fumes (as in barns) would harm other types of wire.



GENERAL INSTALLATION REQUIREMENTS. All bends in cable must be gradual so that the outer cover will not be damaged. Run cable in continuous lengths, from box to box. Splices, as for any other type of wiring, must be made only inside boxes. Use straps (fig. 6) for supporting to surface (never use staples). Cable must be anchored at least every 4½ ft. and within 12 inches of every outlet box. See Pages 6 and 7 for determining proper size wire to use.

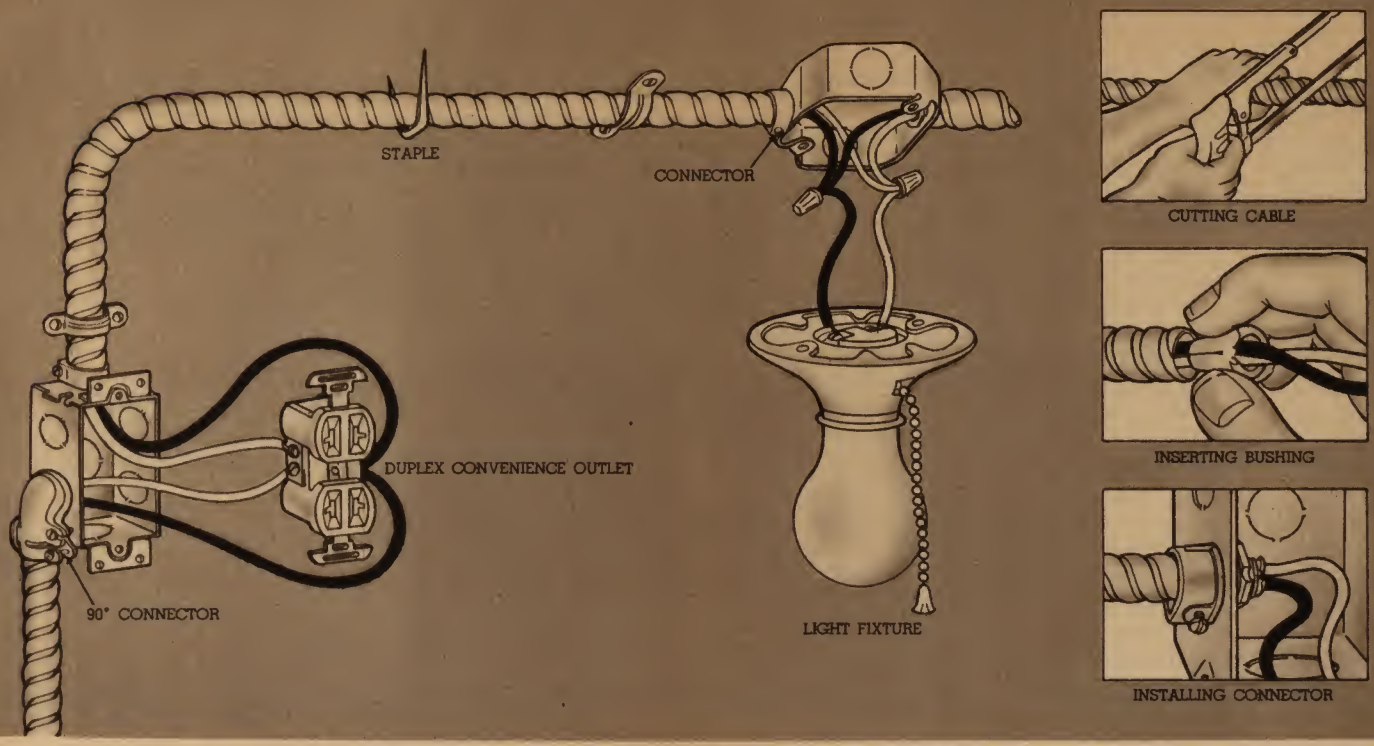
WHERE CABLE RUN IS EXPOSED as in open ceilings or walls of basements, attics, barns etc., it must follow some supporting surface and be given reasonable protection against mechanical injury. The easiest way is to run cable along the side of a stud or joist. If run is across or at right angle to such timbers, cable must be protected by mounting on a running board as shown above. In unfinished basements, if a flush ceiling is desired, you may run it through bored holes through the center of joists.

When passing through a floor, protect cable by encasing it in conduit or pipe extending at least 6 inches above floor.

IN WIRING ATTICS, cable can be run at an angle across top of floor joists providing cable is either mounted on a running board or protected by guard strips (mounted parallel along sides of cable). Protect cable the same way if run is across the face of attic rafters at heights of 7 ft. or more above floor; otherwise, no special protection is needed. If the attic space is not accessible by permanent stairway, running board or guard strips are required only within 6 ft. of entrance. Never take short cuts across free space—always follow approximate contour of building.

CONCEALED WORK. Follow general installation requirements. If wiring new buildings, use straps as outlined, whether cable will be concealed or left exposed. In old buildings, where cable is fished through floor or wall, straps need not be used. Use straps for all exposed work.

TESTING WIRING—after wiring is installed, it should be tested before the power is connected. See opposite page.



How to install armored cable

Armored cable (BX) provides a continuous ground, gives wires ample protection against mechanical injury—yet is flexible and easy to install. Use armored cable indoors, in dry locations. It is subject to the same installation requirements as non-metallic sheathed cable—read steps for "exposed" and "concealed" work outlined on the opposite page. Use with steel outlet boxes only (never with bakelite or porcelain boxes). See Pages 6 and 7 for size wire to use.

CUTTING THE CABLE—use a hack saw to remove spiral wound steel armor. Hold the saw at right angles to the strip of armor as shown above, and carefully cut through one section of the armor—be sure that saw goes only through armor and does not touch the insulation of the wires. Then simply grasp cable with one hand on each side of cut, give it a sharp twist, and remove the short end. Expose about 8 inches of insulated wire for connections.

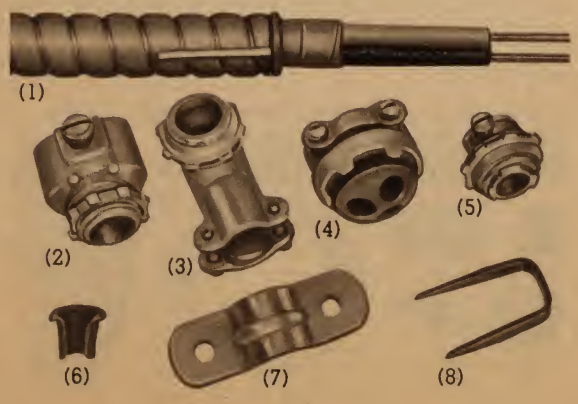
INSERTING THE BUSHING—after the armor has been cut, the resulting raw edge might injure the insulated wires; therefore, a protective fiber bushing (6) must be inserted at the cut end of cable. To allow room for bushing, unwrap paper (spirally wrapped around wires) up to a few turns *under* armor and then yank sharply so that it will tear off *inside* armor; then insert bushing as shown above. Fiber bushings are furnished with all Wards armored cable. Sizes 14- and 12-ga. cables have a bonding wire which should be bent back (see fig. 1) before inserting bushing.

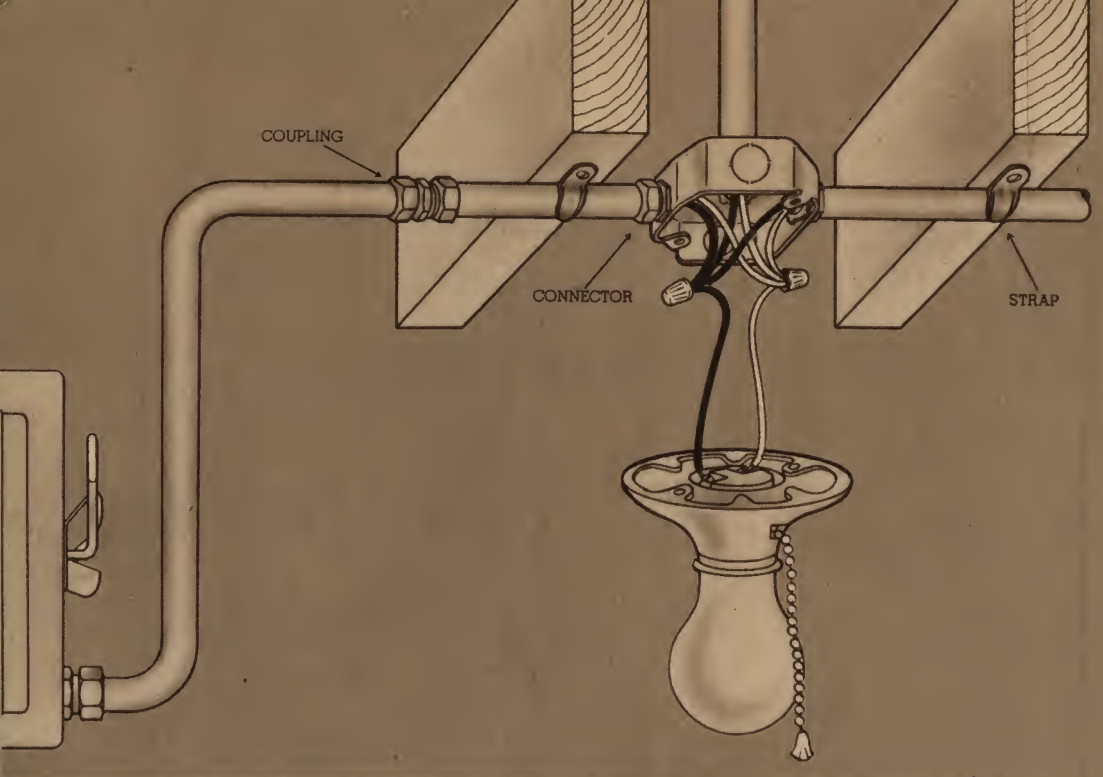
CONNECTING TO OUTLET BOXES—after bushing is installed, slip a connector (5) over end of cable (if using boxes with built-in cable clamps, connectors are unnecessary) and fasten by tightening screw as illustrated above. Then insert connector into knockout hole of box and anchor securely by driving the connector locknut solidly home on the inside of the box to insure a strong and well grounded connection. Cable must be supported with straps or staples (see figs. (7) and (8) at every 4½ ft. and within 12 inches of every outlet or switch box, except for concealed runs in old work where cable is fished through walls or ceilings.

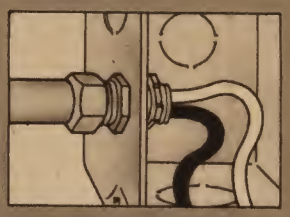
FITTINGS COMMONLY USED WITH ARMORED CABLE are pictured below. Use duplex connector (2) when fastening 2 pieces of cable through 1 knockout. Use (3) for 90° turns. Use (4) to change from 2- or 3-wire cable to open wiring.

TO TEST WIRING INSTALLATIONS . . .

all you need is an ordinary door bell and two dry cell batteries. Make sure that regular power is disconnected before testing. After the wiring is installed, twist together temporarily all wires which will be spliced. At points where a switch is to be installed, couple wires together just as if switch were in "on" position. Then connect 2 dry cells in series (run a wire from center terminal (positive) of one cell to negative terminal of the other. Attach lead wires to the remaining terminals of battery and hook across the wires of circuit to be tested. Touch door-bell wires across each pair of wires at outlet boxes—if the wiring is ok, bell will ring. For armored and conduit systems, check also for a continuous ground: at each outlet, connect door-bell between black wire and the box. If the bell doesn't ring, tighten all locknuts on connectors.







INSTALLING LOCKNUT

90° AND OFFSET BENDS

USING CONDUIT BENDER

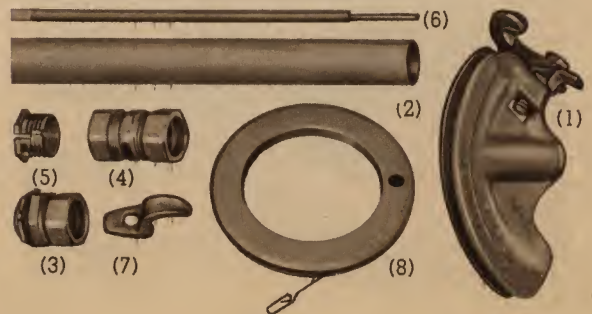
How to install thin-wall conduit

Use thin-wall conduit indoors or out, in wet or dry locations. It comes in 10-foot lengths—couples together and connects to boxes with threadless, pressure-type fittings. Conduit provides a continuous ground—use only with steel outlet boxes, never with plastic or porcelain.

BENDING CONDUIT. Make bends as gradual as possible, taking care not to kink or collapse conduit at point where bending, so wires can be pulled through easily. No more than four quarter bends or its equivalent should be made on any conduit run—the fewer bends, the easier it is to pull wires through. The preferred and easiest way to bend conduit is with the use of a conduit bender, (1) below.

CUT THIN WALL CONDUIT WITH A HACKSAW. Then ream inside to remove sharp edges which might damage wires as they are pulled through. Remove outside sharp edges with file so that fittings can slide on easily.

CONNECTORS. Conduit is fastened to boxes using connector (3) pictured below. Fit threadless end of connector over the conduit, and tighten compression nut; then insert threaded end through knockout of box and screw locknut tightly against the box from the inside as illustrated above. Conduit lengths (2) are joined together with coupling (4). With threaded adaptor (5) you can join a length of thin-wall to rigid conduit.

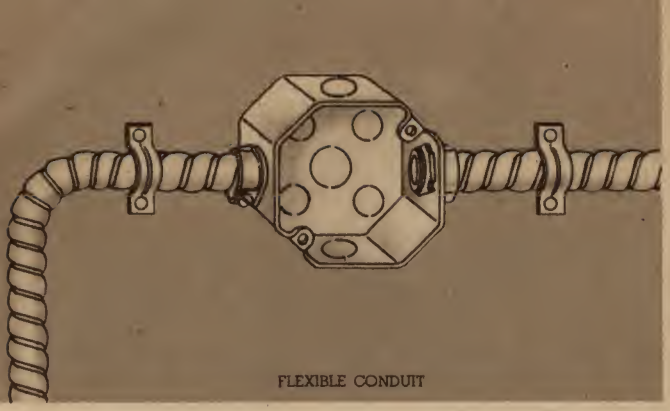


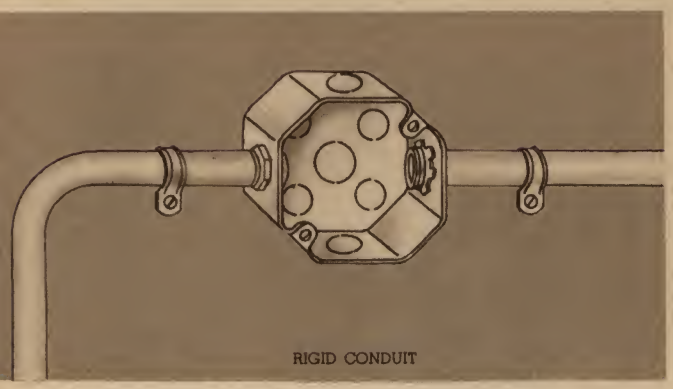
INSTALLATION PROCEDURE. Conduit must be mounted in place and connected to switch and outlet boxes before pulling insulated indoor wires (6) into it. Wires must be continuous inside conduit—make splices and connections only inside boxes. Anchor conduit to surface with a pipe strap (7), every 6 feet on exposed runs, every 10 feet on concealed runs.

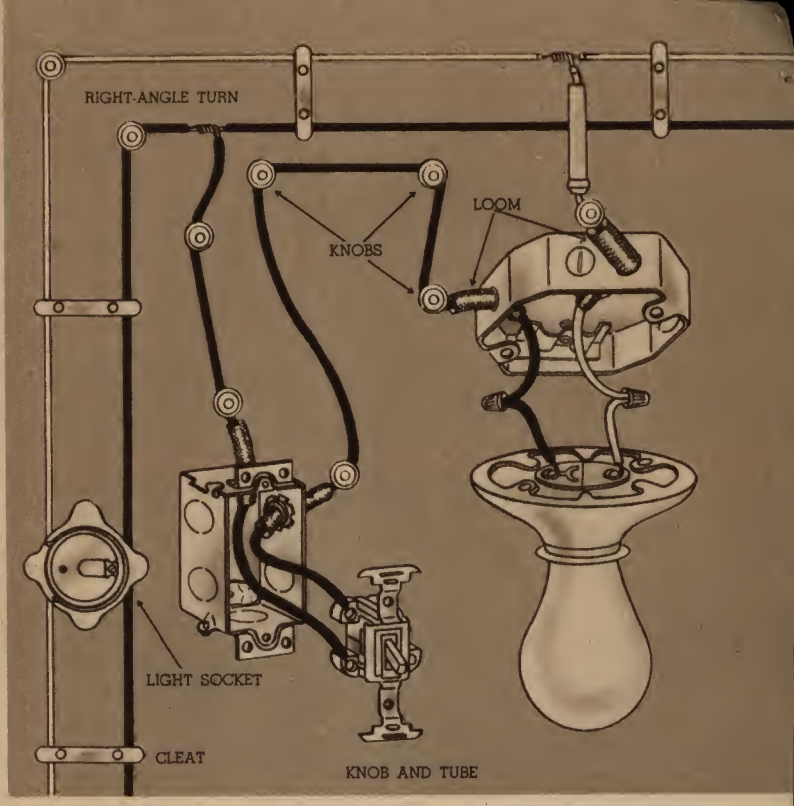
INSERTING WIRES INTO CONDUIT. After conduit is installed and connected to boxes, insert the wires. In a 2-wire circuit, use one white insulated wire for the "neutral" or ground and one black for the "hot" wire. In a 3-wire circuit, use 1 white, 1 black and 1 red. Where the run is short and has only 1 or 2 gradual bends, simply insert wires at one end of conduit and push through to the next outlet. If the runs are longer and there are sharp bends, use Fish Tape (8) or a length of springy wire to pull wires through conduit. Fish tape is a special stiff but flexible wire that will go around corners easily without buckling. Fish tape is pushed through conduit first; then where end emerges, wires are hooked firmly to fish tape and pulled through. Leave 6 to 8-inch projection of wires at each box for making connections. Testing procedure outlined on Page 15.

CONDUIT SIZE AND AMPERE CAPACITY OF WIRES IN CONDUIT

Number of wires (1 to 9) to be installed in conduit (exact number will vary according to local code)					
Size Wire	Ampere Capacity	½-inch Conduit	¾-inch Conduit	1-inch Conduit	1¼-inch Conduit
14	15	4	6	9	9
12	20	3	5	8	9
10	25	1	4	7	9
8	35	1	3	4	7
6	45	1	1	3	4
4	60	1	1	1	3
2	95	1	1	1	3







OTHER TYPES OF INTERIOR WIRING

FLEXIBLE CONDUIT WIRING SYSTEM

Flexible conduit, sometimes called "Greenfield," is similar to the protective steel casing of armored cable without the wires. Although not in wide use for general household wiring, "Greenfield" is an excellent material for use where flexibility is required or where other conduit wouldn't be suitable. For example, rigid-type conduit would be impracticable where a motor is installed with a sliding base to take up belt slack.

Where used for house wiring, "Greenfield" is installed and used just like armored cable except that wires, as with other kinds of conduit, are pulled through later.

RIGID CONDUIT WIRING SYSTEM

The sizes and dimensions of rigid conduit and water pipe are identical, but conduit is especially annealed to permit easy bending. The inside surface is made smooth so that the wires can be pulled into it with a minimum of effort and without damage to the insulation. Cut and thread rigid conduit with the same tools used for water pipe.

Rigid conduit comes in black-enameled or galvanized finish—use black indoors only. Except for the use of threaded connectors and bushings, the installation procedure and code requirements are the same as for thin-wall conduit covered on the opposite page.

HOW TO INSTALL THE KNOB AND TUBE WIRING SYSTEM

Knob and tube system was the original method of installing wiring. It is not as popular today as other systems but is still acceptable in some localities. The use of various size insulated indoor wires with porcelain fittings in "knob and tube" wiring may be subject to local code restrictions. Larger than #10 wire is not recommended for knob and tube work. Check code before installing this system.

USE WHITE WIRE FOR "NEUTRAL" OR GROUND and black or red for the "hot" wires. No connectors are needed at outlet or switch boxes; use boxes with non-metallic clamps—just tighten clamps inside the boxes. Run wires through loom where entering boxes—see illustration.

WIRES ARE SUPPORTED WITH PORCELAIN NAIL KNOBS OR CLEATS along walls or ceilings. Use knobs for supporting single wires for either exposed or concealed work. Use cleats on exposed work only for supporting two parallel running wires. In attics, use knobs only. Never use staples.

PORCELAIN TUBES are used to protect single wires when passing through timber. (Bore holes for tubes at an angle so that tube won't fall out.) Use tubes also where extra protection is desired as where wires cross each other.

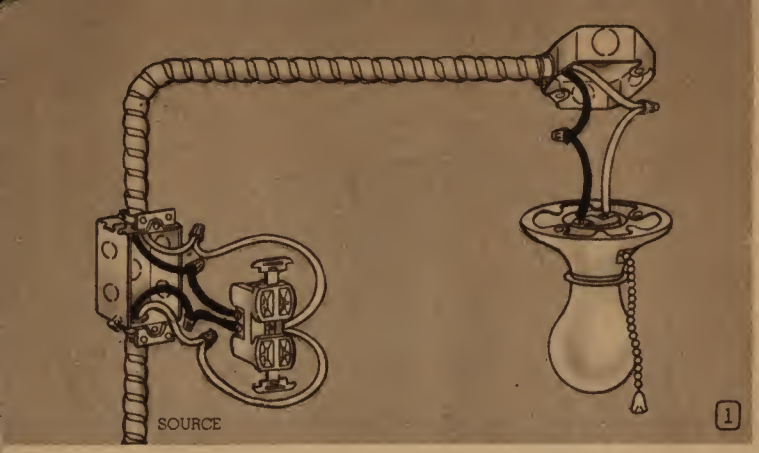
LOOM is a flexible non-metallic covering used for protecting wires where they enter boxes or where they run close together. Run each wire through a separate loom.

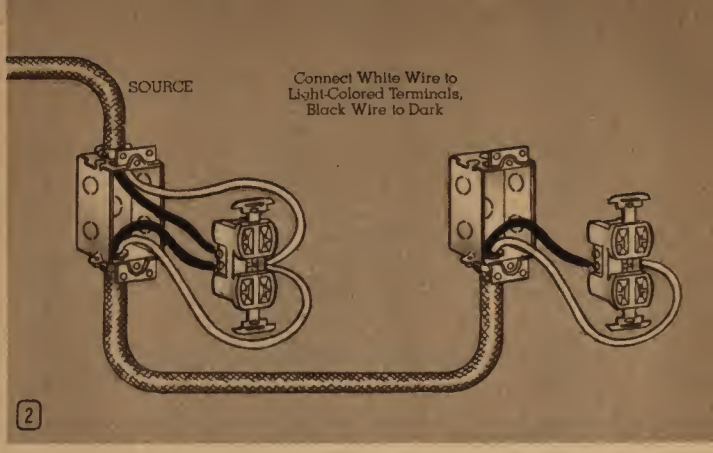
WHERE THE INSTALLATION IS CONCEALED, wires must be kept at least 3 inches from each other and at least 1 inch from the supporting surface. So use knobs and support each wire at least every 4½ feet. If possible, run each wire along a separate stud of wall or ceiling.

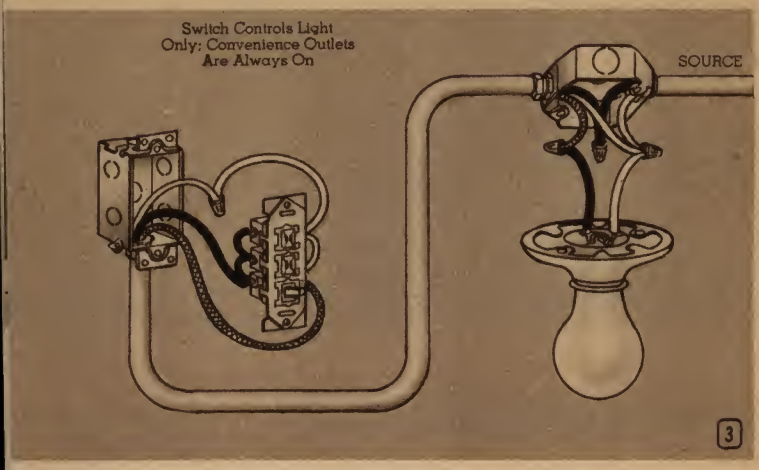
In old work, where the wires are fished through the walls, the National Electrical Code permits fished wires loose within walls, but each wire must be concealed inside of a continuous length of loom.

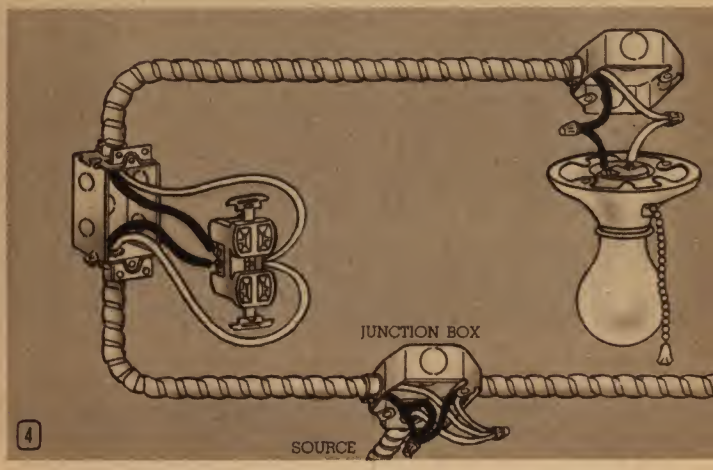
WHERE THE WORK IS EXPOSED wires must be kept at least 2½ inches from each other and must be at least ½ inch from the supporting surface. Support wires with knobs or cleats at least every 4½ feet.

In exposed runs where cleats are used, make right-angle turns or corners with two knobs (proper spacing cannot be maintained with cleats at corners). Where wires run across joists or where they will be subject to mechanical injury, install guard strips (run parallel with wires), or mount wires on a running board (illustrated on Page 14).









How to install plug-in outlets

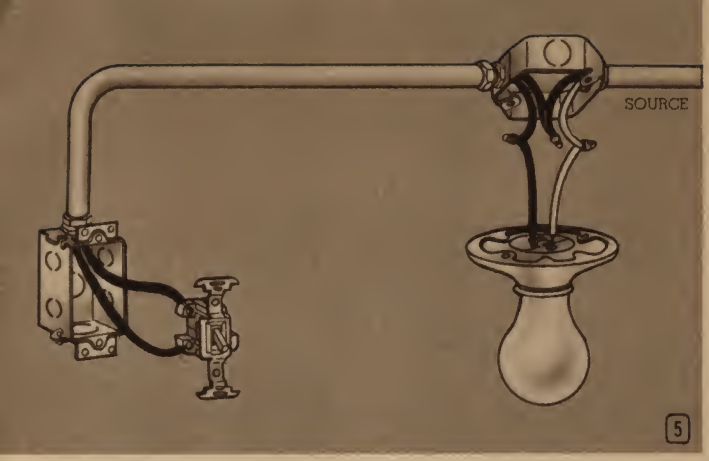
One current-carrying "hot" wire and one "neutral" wire must run to every 110-120 volt current consuming device. Using 2-wire cable, the black colored wire is "hot"; using 3-wire cable, black wire and red wire are "hot" —"*neutral" wire is always white.* To trace current flow, simply consider wires running from previous outlet as the source, and imagine that electricity flows over the "hot" wires, through the current consuming device and back to the source over the "neutral" wire. "Neutral" wires always run to current consuming device without interruption by a switch or fuse—only "hot" wires are attached to switches. Join black wires to black or red wires, never to white, except at switch loops in cable installations where white wire is painted black at both ends—such as in (7). At outlets, connect "hot" wires to dark (brass colored) terminals, white wires to light terminals.

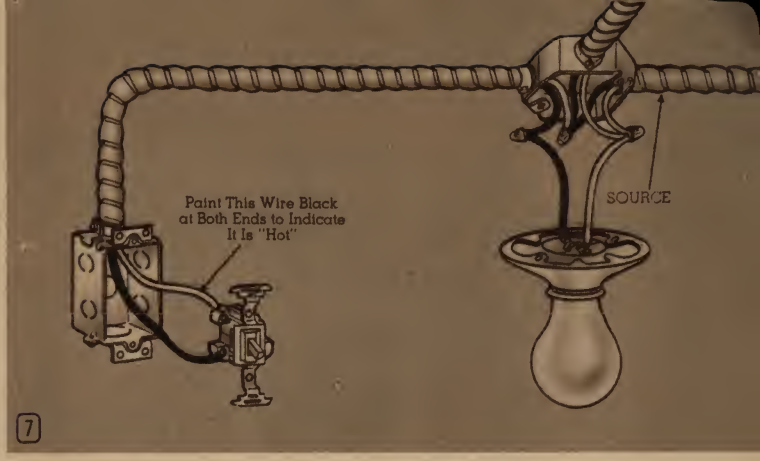
[1] ADDING A PLUG-IN OUTLET IN MIDDLE OF EXISTING RUN. Plug-in outlets are easy to install. Select the spot where outlet will be located and prepare opening for the outlet box. Then tap into existing run with the use of short lengths of wire and screw-on solderless connectors as shown. Simply connect the white wires to light-colored terminals of the receptacle and connect black wires to dark-colored terminals on the opposite side. Notice in the illustration that receptacle will always be "on" as pull-chain will operate light only.

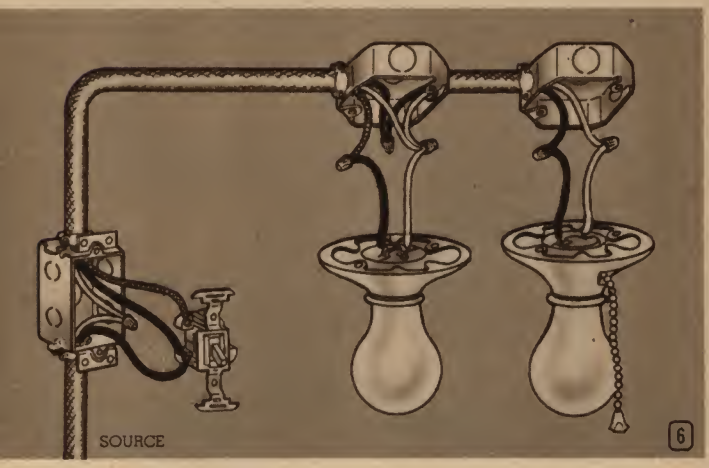
[2] ADDING NEW PLUG-IN OUTLETS BEYOND EXISTING PLUG-IN OUTLETS. You should have at least 1 plug-in outlet every 12 feet along the walls in living room, bedrooms and other general living areas so that an extension cord is never needed. Wiring from one plug-in outlet to another is easy. Use 2-wire cable—non-metallic sheathed, armored or two wires in conduit to install. Connect the black wire to the brass-colored terminals of each outlet and the white wire to the light-colored terminals. Handy "plug-in strip" (shown below) provides as many outlets as desired—mounts above baseboard, over counter top in kitchen, in workshop, etc.

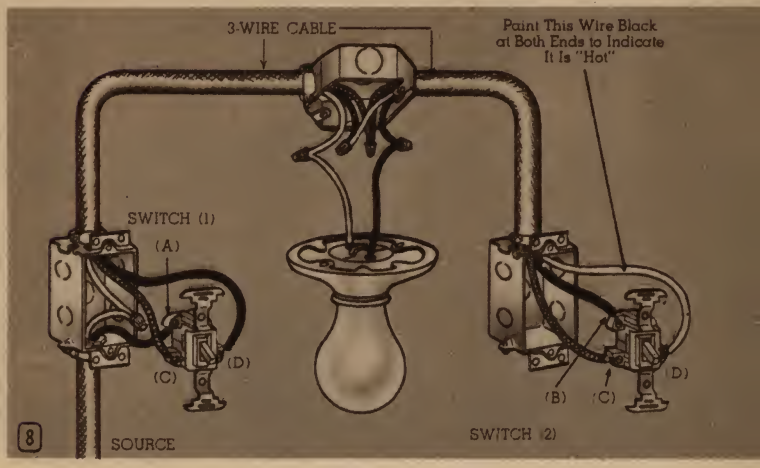
[3] ADDING A COMBINATION WALL SWITCH AND PLUG-IN OUTLETS TO EXISTING CEILING LIGHT. Where practical, this compact device affords greater convenience. Use conduit or 3-wire cable. Tap into white "neutral" wire running to fixture and connect to light-colored terminals of plug-in outlet; disconnect black "hot" wire from fixture and run to 3 brass-colored terminals—study picture at right. Run red wire from remaining terminal on switch to black wire of fixture. Switch controls light only—"plug-ins" are always on.

[4] ADDING A PLUG-IN OUTLET AND PULL-CHAIN LIGHT FROM AN EXISTING JUNCTION BOX. This installation is usually made where a junction box is under floor as in basement below and outlet is to be located on floor above. Use 2-wire cable—non-metallic sheathed, armored or conduit with 2 wires. Remove the cover of junction box and tap cable wires into corresponding colors of wires in junction box as shown. At plug-in outlet, connect black wire to brass colored terminals and white wire to light colored terminal. Connection from receptacle to pull-chain light are same as for installation (1). Note that pull-chain operates light only—plug-in outlet is always "on."









How to install toggle switches

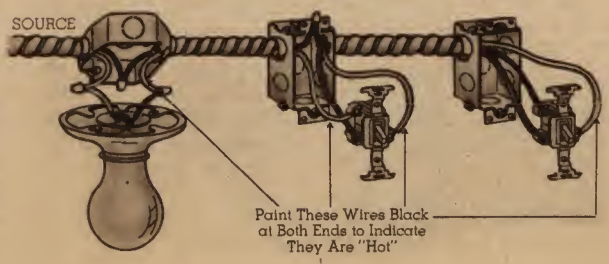
5 ADDING A WALL SWITCH TO OPERATE AN EXISTING LIGHT FIXTURE. This installation is commonly made where the convenience of a wall switch is desired . . . where either no switch exists or pull-chain switch is to be replaced. Run conduit using 2 black wires as shown (or if you are using 2-wire non-metallic or armored cable in which case you paint the white wire of cable black at both ends) from the light to the point where the switch is to be located. Inside the ceiling outlet, disconnect the black "hot" wire from the fixture wire and connect to wire running to switch. Then connect other wire from switch to black fixture wire. Notice that neutral (white) wire is uninterrupted.

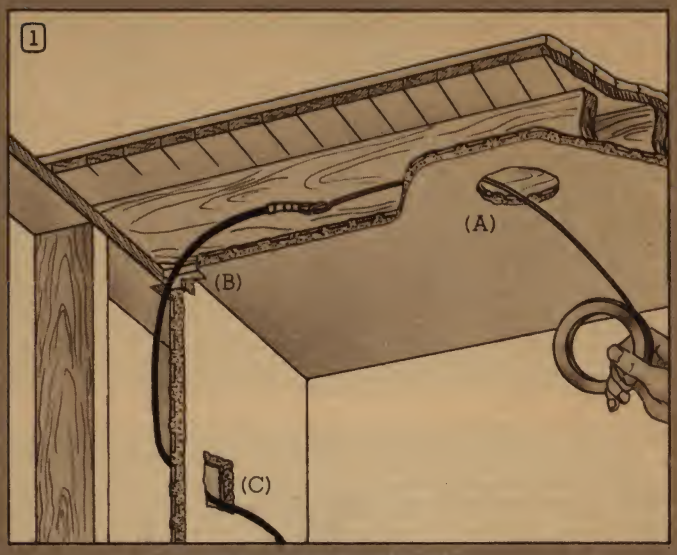
6 INSTALLING TWO LIGHT FIXTURES ON SAME LINE, ONE LIGHT OPERATED BY WALL SWITCH. An "old work" example of this hookup would be in a bedroom where a pull-chain closet light is added to an existing ceiling light. Use non-metallic or armored cable—conduit may be used for "new work." Run 3-wire cable from switch box to first outlet—2-wire cable from first outlet to second. Run the white wire from switch box to both fixtures as shown. Run red wire from one terminal of switch and connect to black fixture wire at first fixture. Run black wire from other terminal of switch and connect to black wire at second fixture.

7 ADDING A SWITCH TO OPERATE CEILING FIXTURE. Using cable, this hookup is an example of a case where black wire may be connected to white. This circuit is continuous through the ceiling light to other outlets. The incoming neutral (white) wire runs direct to outlet, as usual, and continues to other outlets. The incoming black "hot" wire is tapped off to white wire of cable from switch—the black wire of this cable must be connected between other terminal of switch and black fixture wire as shown.

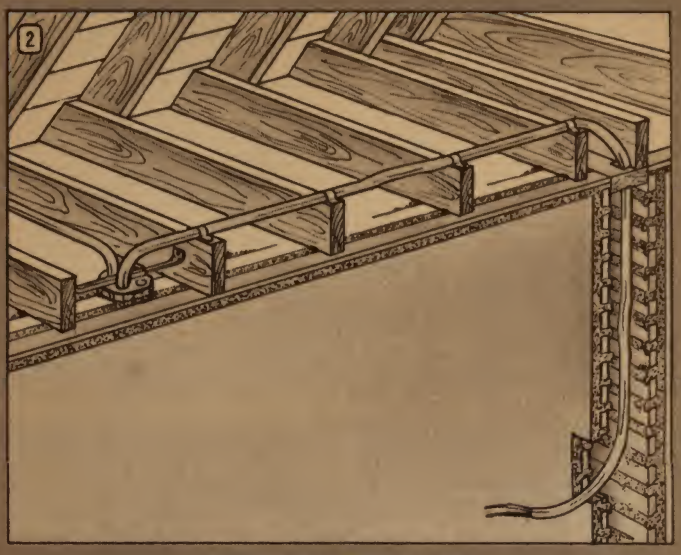
8 HOW TO INSTALL "3-WAY" SWITCHES. The ordinary wall switch used to control light from one point is known as a "single-pole" switch. To save steps or stumbling in darkness, it is desirable to be able to turn a light on or off from two different points such as a hall light from upstairs and downstairs. For this purpose two "3-way" switches are used. Using 3-wire cable, make connections as shown. Run the white "neutral" wire from source direct to the light fixture. Connect the black wire from source to common terminal at point (A) of first switch. (The common terminals of "3-way" switches are generally at top or side and are usually darker color than others.) At second switch, connect black wire of cable to common terminal (B)—the other end is connected to black wire of light fixture. This leaves 2 unused terminals, (C) and (D), at each switch; join red wires together in light fixture box and connect at points (C); connect black wire at (D) of first switch and join to white wire in fixture box which is connected to (D) at second switch.

ANOTHER 3-WAY SWITCH HOOKUP is illustrated below. The 2 switches and outlet can be hooked up in many possible combinations, depending on where the source wires come in.

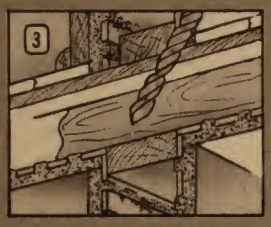




CEILING TO WALL INSTALLATION



RUNNING CABLE THROUGH ATTIC



BEHIND BASEBOARD

DRILLING FROM ATTIC

ADJUSTABLE HANGER

STRAIGHT BAR HANGER FOR "OLD" WORK

How to install switches and

THE WIRING OF BUILDINGS WHILE THEY ARE UNDER CONSTRUCTION IS KNOWN AS "NEW" WORK. Applying the methods described in previous pages, "new" work is simply a matter of running wires along a direct route to various outlets and boxes—installation points are easily accessible. Some local codes require the use of conduit for "new" work. If conduit is used, it is installed before walls of house are completed. Pull wires through after plastering.

THE WIRING OF BUILDINGS AFTER THEY HAVE BEEN COMPLETED IS KNOWN AS "OLD" WORK. In general, there is little difference between the two types except that in "old" work, more cutting and patching is involved. The problem is to prepare openings to fish wires through walls and ceilings with the least effort and minimum disturbance to building. Because actual construction varies, every job will be different. Sometimes by moving an intended outlet or switch to another point, a difficult boring or fishing operation can be avoided. Non-metallic or armored cable material is preferred for "old work" because it is flexible, requires little space and is readily fished through small openings.

[1] RUNNING CABLE FROM OPENING IN CEILING TO OPENING IN WALL. Picture above shows a typical problem of running cable from an outlet in ceiling at point (A), around the corner, point (B), to an opening in wall at point (C) for a toggle switch. At (B), where wall meets ceiling, there is usually a 2 by 4 obstruction that blocks the passage of cable. The usual procedure at this point is to make a temporary opening in the plaster (opening can be patched with ready-mix plaster after wiring is installed), and then with chisel, an opening is notched in 2 by 4 to provide a channel for fishing the cable through. See opposite page for instructions on preparing opening for wall switch.

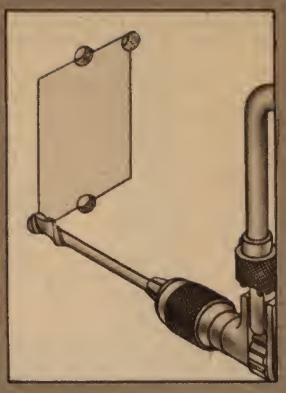
AFTER PREPARING NECESSARY OPENINGS, draw the cable through by using fish wire. For method pictured in figure (1), simply insert a continuous length of fish wire at (A), run to opening at (B) and push down to side wall opening at (C). Then hook and tape cable to fish wire and pull through from opposite end until cable reaches ceiling outlet. Allow about 8 inches of cable to project at points (A) and (C) for making connections.

[2] RUNNING CABLE THROUGH ATTIC. In wiring single-story houses or a second floor of two-story houses, cable can be run through attic, if accessible. Boards of usual rough attic floor can be lifted and hole drilled through any obstruction for running cable through wall space as pictured in Figure (4).

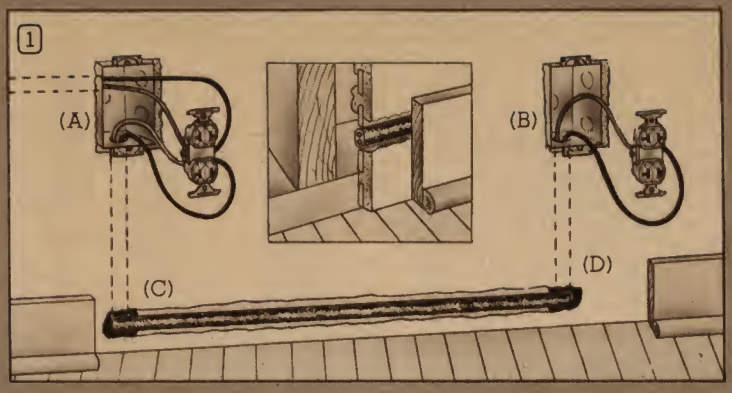
[3][4] RUNNING CABLE FROM AN ACCESSIBLE OUTLET ON SECOND FLOOR TO FIRST FLOOR. Where the second floor partition is directly above first floor partition, as in fig. 3, it is usually simple to bring cable through from floor above by removing baseboard and boring hole through floor. Later, baseboard can be remounted.

[5][6] MOUNTING CEILING BOXES. Whenever possible, use at least a 1½-inch deep outlet box—shallower types may be used in confined spaces. In "old" work where installation space is usually not accessible from above, work must be done from below. Prepare ceiling opening to size of outlet box and insert a straight-type bar hanger into opening as shown at Figure (6). Then turn the hanger at right angles to laths so that when box and light fixture are mounted, weight will be distributed evenly. Where space is accessible as in basement Figure (5) or for "new" work, an adjustable bar hanger may be used.

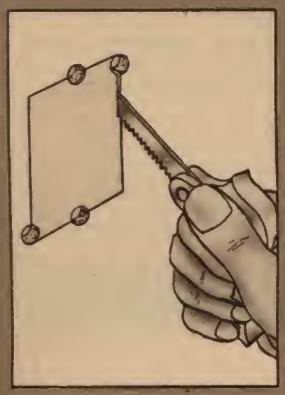
OUTLINE OPENING



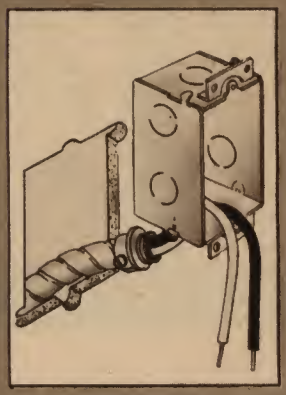
DRILL ½ INCH HOLES



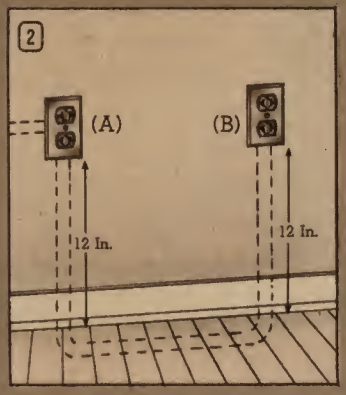
INSTALLING CABLE BEHIND BASEBOARD



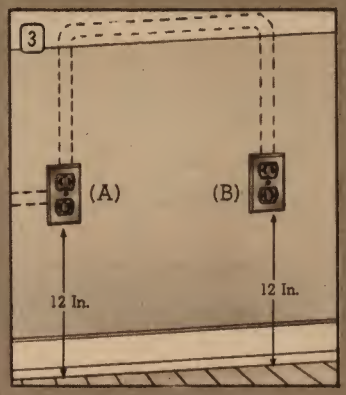
USING KEYHOLE SAW



INSTALLING BOX



CABLE THROUGH BASEMENT



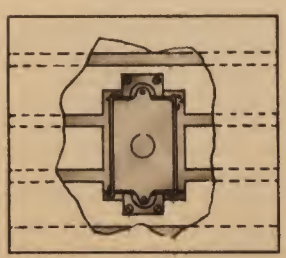
CABLE THROUGH ATTIC

RECEPTACLES IN "OLD WORK"

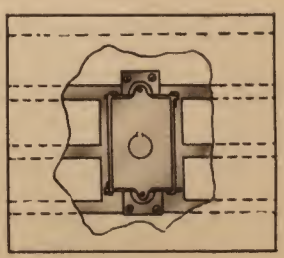
PREPARING OPENINGS FOR BOXES. Wall switches should be placed uniformly about 48 to 54 inches above floor; "plug-in" outlets about 12 to 18 inches above floor—or at table height in kitchen. Locate boxes near studs where stud and laths can give strong support, yet at a point where there will be room to bring cable freely to opening. Usually thumping on the wall will disclose location of studs.

START BY MARKING THE APPROXIMATE LOCATION OF BOX. Then drill a small hole through wall and probe with stiff wire to make sure there is no obstruction from studding. If opening is clear, dig through a small section of plaster to find laths. See diagram below for right and wrong way to cut laths—cut away 1 full lath and part sections of each lath above and below. Then outline actual position of box and drill four ½ inch holes to provide space for keyhole or hacksaw blade as shown above.

USING SAW, cut along outline. Apply pressure as you draw blade toward you. Hold your hand against plaster to prevent plaster from chipping. Attach cable to box with connector and locknut after box is in wall. Fasten box to wall with screws or supports (5).



RIGHT WAY



WRONG WAY

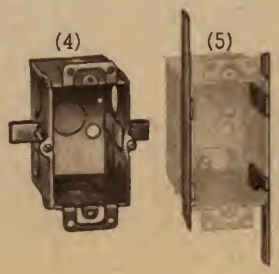
RUNNING CABLE FROM ONE OPENING TO ANOTHER ON SAME WALL. Pictures (1), (2) and (3) show several methods for this installation. The best way will depend largely on the structure of your particular building.

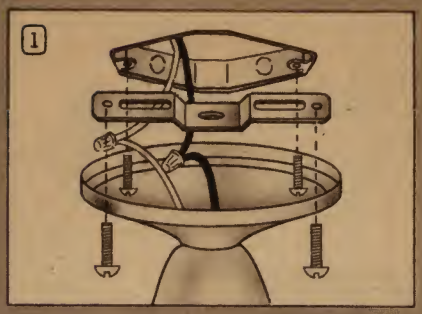
1 WIRING FROM ONE OUTLET TO ANOTHER BEHIND BASEBOARD. Study picture for details of this installation. The first step after preparing openings in wall is to remove baseboard. Then cut small holes (C) and (D) directly below the outlets. The next step is to notch a channel deep enough for cable in the space between 2 laths. Next, cut a length of cable to extend from outlet (A) to (B) and set into groove as shown. Clamp cable securely to boxes and connect wires to outlets—see fig. 2, Page 18. When replacing baseboard be careful not to drive nails into cable.

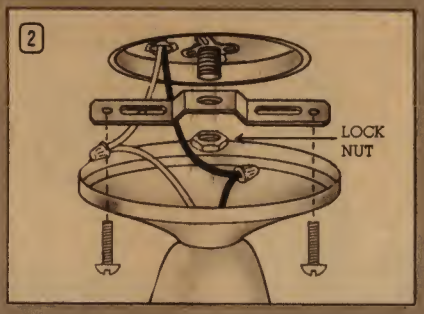
2 WHERE WALL PARTITION IS ACCESSIBLE FROM BASEMENT, it is usually possible to bore directly upward from the basement. Then fish cable up to points (A) and (B).

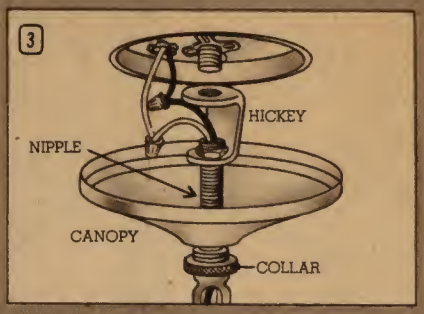
3 WHERE FLOOR BOARDS CAN EASILY BE LIFTED IN THE FLOOR ABOVE (usually in attic), use this method. After preparing openings for (A) and (B), bore holes through partition from floor above and simply drop cable down to openings.

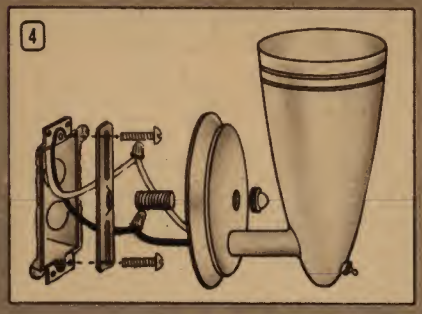
SWITCH OR RECEPTACLE BOXES range in depth from 1½ to 3½ inches—use larger size wherever possible. For old work, we recommend easy-to-install screw-type box (4)—holds firmly to any wall, or use "Hold-It" Box Supports (5) with conventional type boxes.

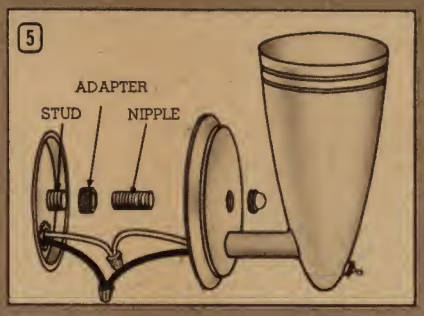


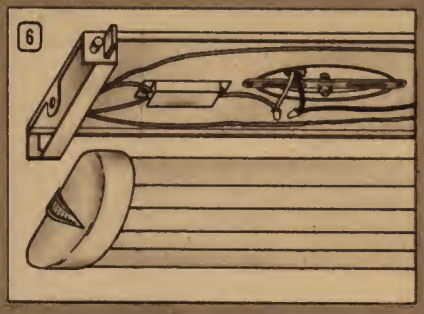












How to install lighting fixtures

Most lighting fixtures come pre-wired, ready to install. On some fixtures, one wire is white, the other black or another color. Sometimes both wires are the same color, but one wire will have a colored tracer thread interwoven in the outer fabric. Always connect the white wire or the tracer wire with the white wire in the outlet box. There are many ways of mounting lighting fixtures; the method used depends on the style and weight of the fixture and the particular outlet box involved. In any case, this phase of wiring is comparatively easy.

CEILING FIXTURE MOUNTED WITH SCREWS

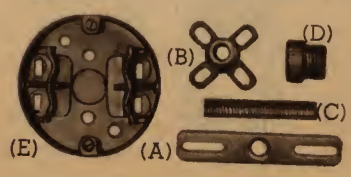
[1] Picture above is self explanatory. Fasten strap (see (A) below) to ears of outlet box; then make proper wire connections. Finally, attach light fixture to strap. Necessary screws, strap and solderless connectors are generally furnished with this type of fixture.

CEILING FIXTURE MOUNTED TO FIXTURE STUD

[2] Fixture studs (see (B) below) are frequently used in mounting heavier fixtures. In the picture above, fixture stud is an integral part of box. But if mounted separately, simply fasten stud to bottom of outlet box (see (E) below) by bolts through holes provided for this purpose. Then slip strap over fixture stud, and anchor it with locknut. Connect wires as shown, and screw fixture holder to strap.

MOUNTING CEILING DROP FIXTURES

[3] Generally a hickey is used for mounting large drop fixtures. The first step is to screw the hickey on the fixture stud. Run wires through hickey and make connections with solderless connectors as shown. Then screw nipple (see (C) below) into lower part of hickey and anchor with locknut. Finally, slip canopy up flush against ceiling and tighten collar. Make adjustments by screwing nipple further into hickey.



MODERN TYPE WALL BRACKET FIXTURES

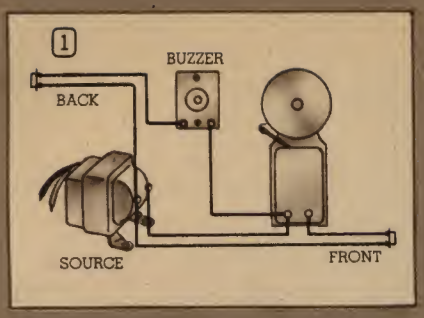
[4] Modern type wall bracket fixtures are often too small or narrow in size to cover up standard outlet boxes. Hence, narrow switch boxes are frequently used for this type of fixture. The installation is simple. Mount fixture strap, such as shown in picture, directly to switch box. Screw in nipple and connect wires as shown. Then place fixture over box so that nipple extends through hole, and fasten fixture to wall using knurled cap.

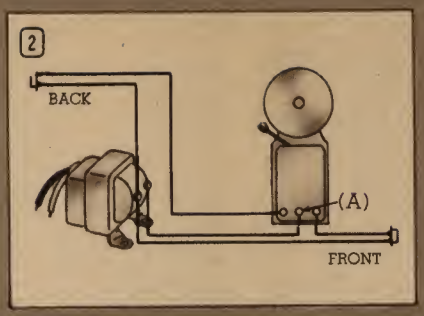
MOUNTING WALL BRACKET TO FIXTURE STUD

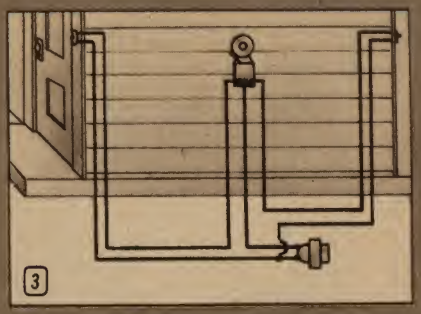
[5] If an outlet box with fixture stud is used, the wall bracket can be installed with the use of a stud adapter or an extension nipple (see (D) below). Simply screw extension nipple or adapter (furnished with fixture) partly on to fixture stud and insert nipple into other end. Connect wires as shown, and fasten fixture to wall with knurled cap.

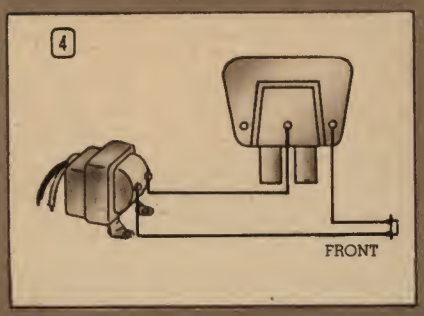
INSTALLING FLUORESCENT FIXTURES

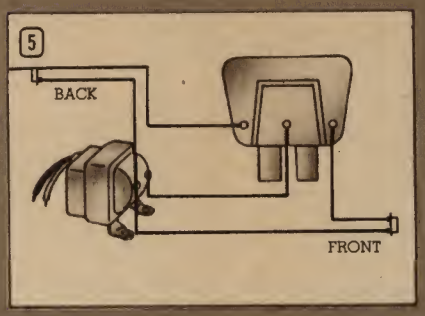
[6] Fluorescent fixtures are installed in the same general manner as are fixtures for incandescent lamps. In general, a fluorescent fixture consists of a chassis to which are mounted the sockets, ballast and wiring. End caps and metal cover (over chassis) are easily removed for making installation. To mount, insert a fixture stud into outlet box; raise chassis and insert strap over stud and anchor with lock nut as shown. (If stud is too short, use an extension nipple (D) at left). Connect wires as shown, and replace cover and end caps.

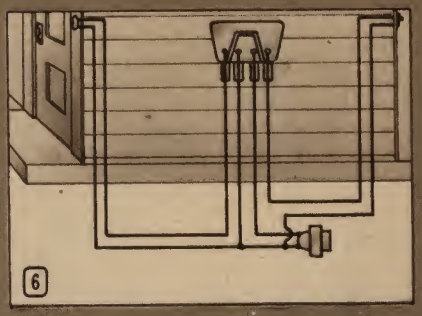












How to install door bells and chimes

Doorbells, buzzers and chimes signal systems operate on low voltage. The power is usually furnished by a low-voltage transformer of the type shown at (B), below. (1½-volt dry cell batteries may be used in which case they are hooked up in series to obtain desired voltage).

THE TRANSFORMER is simply a device that reduces the regular 110-120 volt alternating current to a lower voltage. For doorbells and chimes this ranges usually from 10 to 16 volts. Because of this low voltage, heavy insulated wire is not needed. For ordinary residential use, No. 18 bell wire (see (C) below) is most commonly used.

THE INSTALLATION IS SIMPLE. The transformer is mounted on a surface, or outlet box; and the two "primary" lead wires are permanently connected to the 110-120 volt line. The two "secondary" screw terminals are used for the low-volt-bell-wire connections. Mount signal devices where desired. Bell wire may be run over exposed surfaces, behind baseboards, under mouldings or fished through walls without further protection. Use insulated staples for anchoring wire to surface.

To trace current flow, simply consider the transformer as the source, push buttons as switches and the signaling devices as outlets. When push button is pressed, contact is made to complete the circuit and device will operate. When push button is released, the circuit is disconnected to stop flow of current.

DOORBELL AND BUZZER HOOKUPS

1 DOORBELL AND BUZZER. This circuit provides a buzzer for the back-door entrance and a bell for the front door. Run wires from one of the transformer terminals to each push button. Next, connect bell and buzzer to respective push buttons. Finally, run wire from second terminal of transformer to bell and on to buzzer as shown. The system is now ready to operate. Each push button will operate its corresponding device only.

2 3 COMBINATION BELL AND BUZZER. In this circuit the buzzer for the back door and the bell for the front door are combined into one unit. This device has three terminals. One of these three terminals (A) is usually fastened directly to the frame of the device and is connected to the transformer. The two remaining terminals go directly to the push buttons. Connect wires as shown. Figure (3) shows installed view.

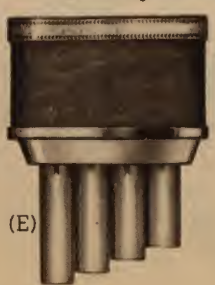
HOW TO INSTALL MUSICAL CHIMES

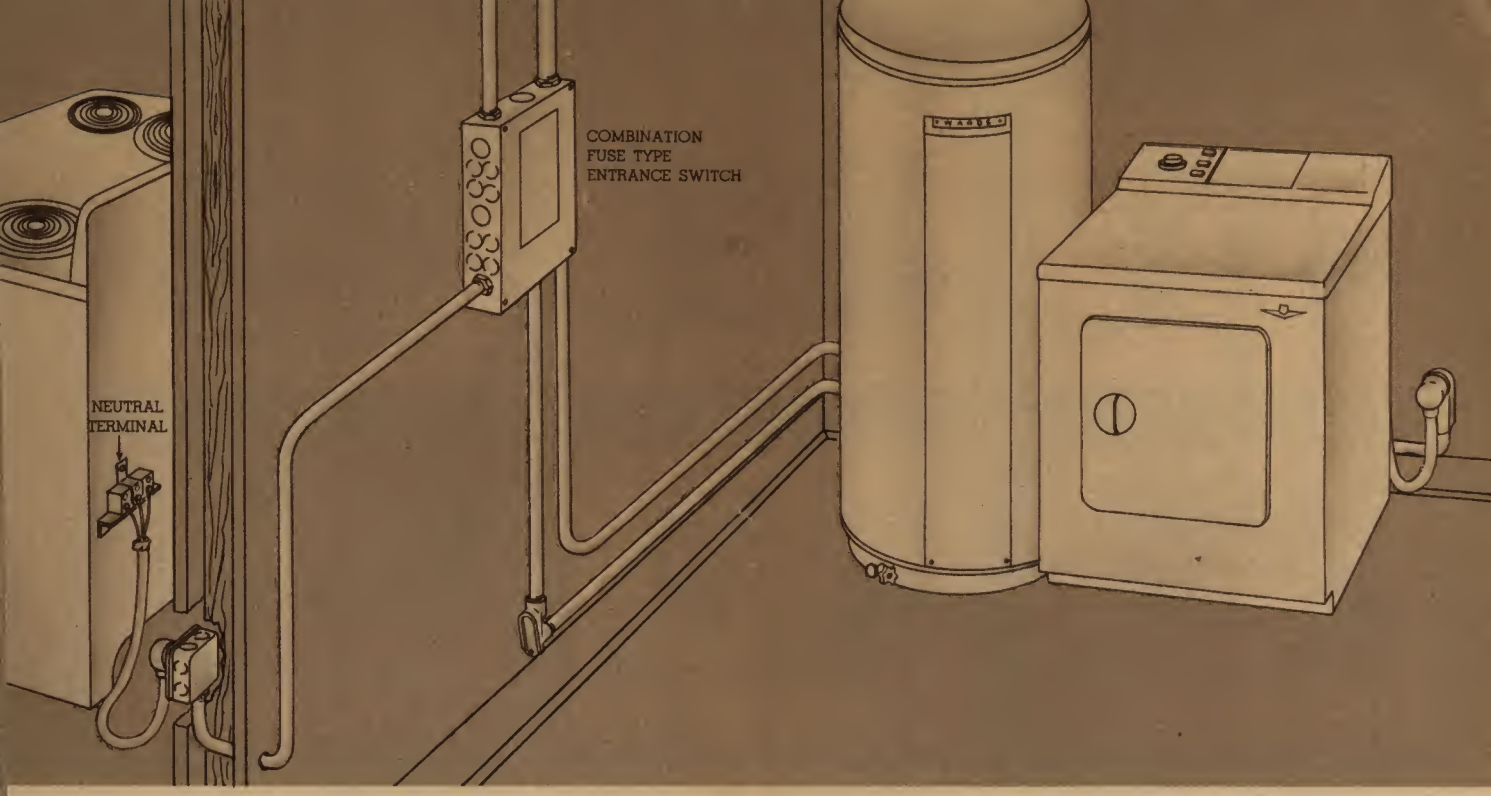
Chimes are rapidly coming into favor over the doorbell. Instead of the continuous harsh sound of a bell, chimes produce a pleasing sound or combination of sounds—see Figure (D), (E) below. The notes are not repeated until the push button is released and pressed again.

The wiring for chimes is essentially the same as for bells. Most chimes require a 10- or 16-volt transformer.

4 5 1- AND 2-NOTE CHIMES. Study Figure (4) for installation to front entrance. At Figure (5), push button for rear door is added to same circuit. Chime will sound 1 note at back door, 2 notes at front door.

6 DELUXE 4-NOTE CHIMES sound 1 note at back door, 4 notes at front door. Study picture for hookup. All Ward chime kits include complete wiring instructions.





How to wire for 220-volt appliances

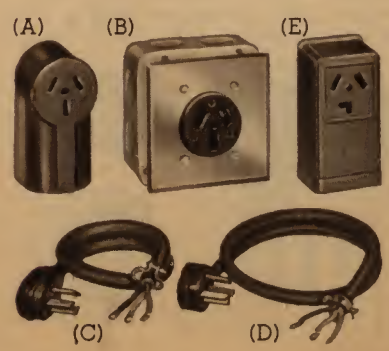
Major appliances operating on 220-240 volts such as the range, water heater and clothes dryer illustrated above require individual circuits (see Pages 6 and 7).

Providing that an adequate service entrance assembly (Wards recommend a 100 ampere entrance switch) is in place, the wiring for heavy appliances is quite simple.

ELECTRIC RANGE INSTALLATION

Practically all ranges operate on 220-240 volts. On higher heats, they operate on 220-240 volts; at lower heats, they operate on 110-120 volts. Therefore, a 3-wire circuit is required. You may use either 3-wire cable or 3 wires in conduit for run between the fuse cabinet or circuit breakers and the range receptacle as pictured above. Install a heavy-duty receptacle rated at 50 amps, 220-240 volts of the types shown below, (A) Surface Mount, (B) Flush Mount, at the point where range is to be located.

Use either No. 6 or No. 8 wires or cable, depending on wattage of range (heavier No. 6 is preferred). If conduit is used, be sure neutral wire is white. Service-entrance cable may also be used for hookup from fuse box to receptacle, in which case the bare neutral wire is connected to neutral terminal of receptacle. Check local codes for proper wire or cable to use.



The range is connected to a 3-wire "pig-tail" cord (C) which plugs into range receptacle (to disconnect range pull plug out). The frame of the range is grounded to the neutral terminal on the range—be sure that neutral wire of "pig tail" runs to this terminal.

ELECTRIC WATER HEATER INSTALLATIONS

There are a number of methods used in wiring water heaters. The choice of method and type of water heater (single or double element) used must be determined by consulting your local utility company. In many localities, the utility company supplies power for water heaters at a reduced or off-peak rate. In this case, the heater may be on a separate meter and time switch assembly (installed by the utility Co.) to permit use of electricity to heater only during specified night hours when the demand for current is the lowest. The entire cycle is automatic. By using a large capacity 60- to 90-gallon tank, enough hot water can be stored to last until the following day.

The power consumed by water heaters ranges from 1500 to 4000 watts, 220-240 volts. Unlike electric ranges, they are never combination 110-120/220-240 volt devices; hence only 2 wires, both "hot" (usually 12 gauge), are needed—a neutral or white wire (unless painted black at both ends to indicate it is "hot") is not used for water heaters.

A means for disconnecting the water heater circuit is required. Using a modern fuse type combination entrance switch (described on Page 12) as pictured above, the circuit is disconnected by removing pull-out block serving the heater. If circuit breaker entrance switch is used, provide a 30-amp, 2-pole breaker for heater. Otherwise, a separate disconnect switch is required.

ELECTRIC CLOTHES DRYER INSTALLATIONS

3-wire cable or 3 wires in conduit or service entrance cable must be used for 220-240 volt clothes dryer installations. Check local utility company requirements. Usually No. 10 or heavier wire is used, depending on wattage of dryer. As in the case of water heaters, a circuit disconnect (pull-out cartridge fuse block, circuit breaker or a separate disconnect switch) must be provided. The frames of dryers must be grounded. Illustration above shows installation of a special dryer "pig-tail" cord and heavy-duty receptacle of the types (D) and (E) pictured at left.

ELECTRIC MOTORS AND THEIR USES

Motors are used extensively today for all types of jobs—on the farm and in the city. On modern farms, they are indispensable for saving time and cutting operating costs. They use electricity only in proportion to the power they are called upon to deliver. A one-horsepower motor, at average electrical rates, will work for as little as 5c an hour. Running continuously, it will deliver the equivalent energy expended by 10 men, in an 8-hour period.

Motors are low in initial cost and require little maintenance; with reasonable care, they will give efficient service for years—in hot or cold weather.

STARTING AND OVERLOAD CAPACITIES

All motors have a built-in overload capacity which enables them to develop, for a short period, the extra power needed for handling initial starting load requirements. They will also safely handle momentary emergency overloads while in full operation—providing overload is not continuous. For example, when starting a fully loaded machine, or when a knot is encountered while sawing lumber, the necessary extra power is developed without the use of complex clutch and gearing mechanisms. In short, a good motor will develop from 1½ to 4 times its rated capacity. No motor, however, should be deliberately overloaded continuously as it will burn out unless some means of overload protection is provided. If overload protected (time-lag fuse or built-in overload protector), the motor will shut off automatically if the overload continues.

HOW TO FIND RIGHT WIRE SIZE FOR MOTORS

Check name plate on motor for rated horsepower, then measure the distance from motor to fuse box or meter and consult table below for proper size wire to use.

In general, two good rules to follow are: (1) never skimp on wire size and (2), on ¾-HP or above use 220-240 volt 3-wire service, if available. The size of wire used must be big enough to handle rated capacity of motor plus the extra amperes required for starting and the handling of temporary overloads. The distance from motor to meter must be considered to avoid voltage drop (see Page 9) which causes overheating and loss of power.

MOTOR H.P.	DISTANCE FROM MOTOR TO FUSE BOX OR METER							
	0 to 50 Ft.		50 to 100 Ft.		100 to 150 Ft.		150 to 200 Ft.	
	115 V.	230 V.	115 V.	230 V.	115 V.	230 V.	115 V.	230 V.
¼	14 Ga.	—	12 Ga.	—	12 Ga.	—	10 Ga.	—
⅓	14 Ga.	14 Ga.	12 Ga.	14 Ga.	10 Ga.	14 Ga.	10 Ga.	14 Ga.
½	14 Ga.	14 Ga.	10 Ga.	14 Ga.	10 Ga.	14 Ga.	8 Ga.	14 Ga.
¾	12 Ga.	14 Ga.	10 Ga.	14 Ga.	8 Ga.	14 Ga.	6 Ga.	12 Ga.
1	12 Ga.	14 Ga.	8 Ga.	14 Ga.	6 Ga.	12 Ga.	6 Ga.	12 Ga.
1½	10 Ga.	12 Ga.	8 Ga.	12 Ga.	6 Ga.	8 Ga.	4 Ga.	6 Ga.
3	8 Ga.	14 Ga.	4 Ga.	10 Ga.	4 Ga.	8 Ga.	2 Ga.	8 Ga.
5	6 Ga.	12 Ga.	2 Ga.	8 Ga.	0 Ga.	6 Ga.	00 Ga.	6 Ga.

SELECT THE RIGHT MOTOR FOR THE JOB

Select your motor according to the type of equipment it is to operate and the amount of power that will be needed for continual operation. It is better to buy a motor with a slightly higher rating than is actually needed, as an overloaded motor wastes power and may even burn out.

There are 3 types of single-phase motors (use with single-phase alternating current only) in common use. All 3 types develop rated horsepower efficiently when operating at full speed, but there is a difference in their capacity to start various loads.

[1] SPLIT-PHASE MOTORS. Use for easy starting loads or where the maximum load is applied after the motor has attained full speed—ideal for operating light power tools, washing machines, fans, etc. They are available only in sizes ½ HP or smaller. Do not use for any hard starting machine such as a compressor, pumps, etc.

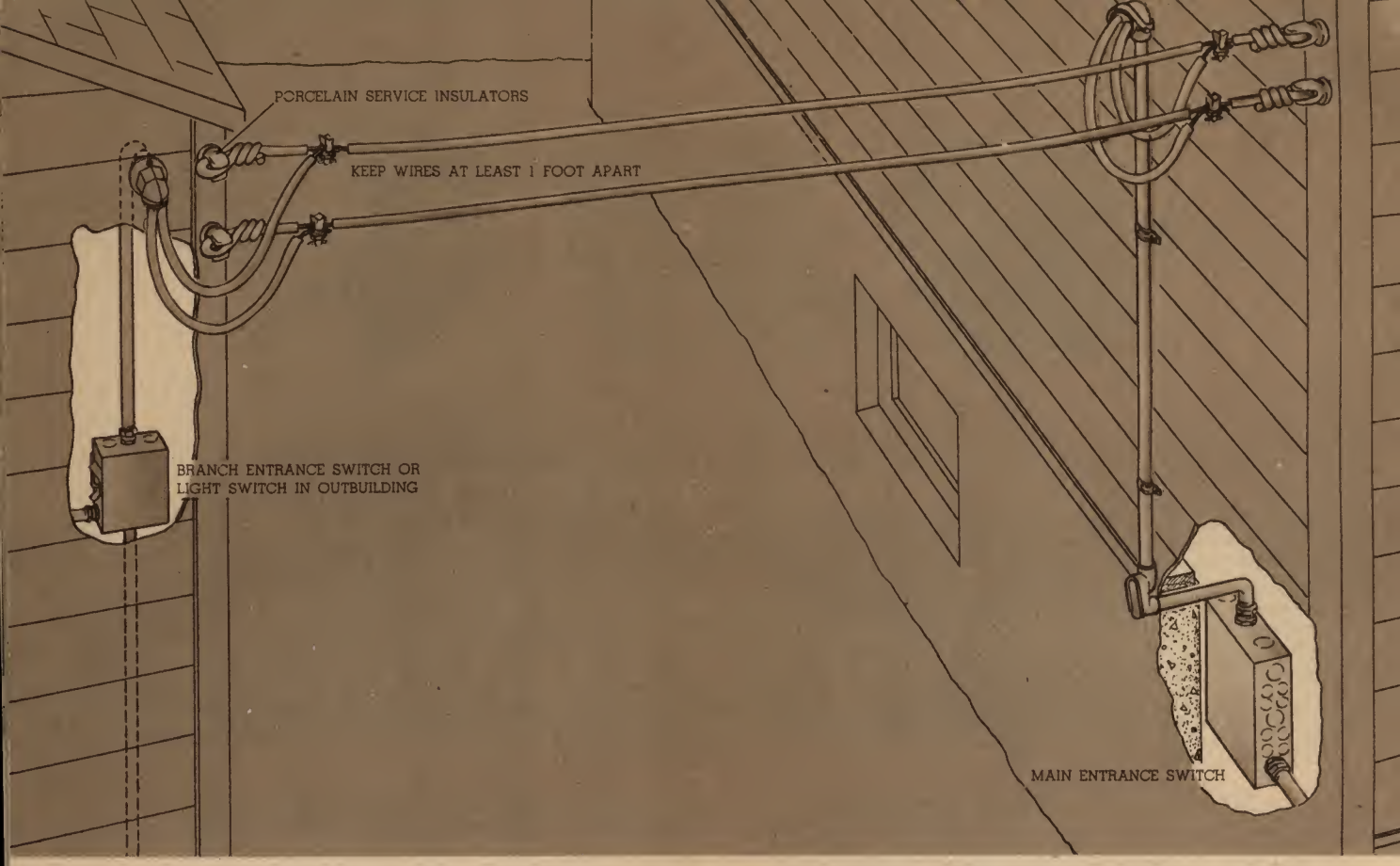
[2] CAPACITOR MOTORS. Similar in construction to split-phase types but with the addition of a condensor which enables it to start heavier loads, and reduces its current requirements for starting. There are several types of capacitor motors. They are most commonly used in sizes ranging from ⅓ to 1 HP. Use for heavier power tools, paint sprayers, stokers, etc. Mill-type capacitor motors are suitable for medium to hard starting loads such as compressors and production equipment.

[3] REPULSION INDUCTION MOTORS. A heavy-duty motor suitable for nearly any kind of general purpose heavy work in severest climates. Has a very large starting ability enabling it to "break loose" almost any hard-starting machine. Its starting current requirements are the lowest of all single-phase motors. Use for deep well pumps, compressors, grinders—heavy-duty farm work.

BELTS AND PULLEYS . . . TABLE OF SPEEDS

Keep belts reasonably slack to avoid motor strain, excessive bearing and undue belt wear. Select pulley combinations for speeds wanted from table below. Machine pulley speeds based on motor speed of 1725 RPM.

Motor Pulley Size	Pulley on Machine: Size in Inches							
	1½	2	2½	3	4	5	6	8
1½ in.	1725	1290	1035	860	645	515	430	320
2 in.	....	1725	1380	1150	860	690	575	430
2½ in.	....	2150	1725	1435	1075	860	715	540
3 in.	....	2580	2070	1725	1290	1035	860	645
4 in.	....	3450	2760	2300	1725	1380	1150	860
5 in.	....	4300	3450	2875	2155	1725	1435	1075
6 in.	....	5175	4140	3450	2585	2070	1725	1290
8 in.	....	6900	5520	4600	3450	2760	2300	1725



How to install overhead wiring

Buildings requiring small loads are usually served from a nearby main building, such as running wiring from house to garage in the city or between large and smaller buildings on the farm. The illustration above shows method for running a 2-wire service from the main entrance switch of house to garage. Larger type installations between farm buildings are described on Pages 28, 29.

USING OUTDOOR WEATHERPROOF WIRE

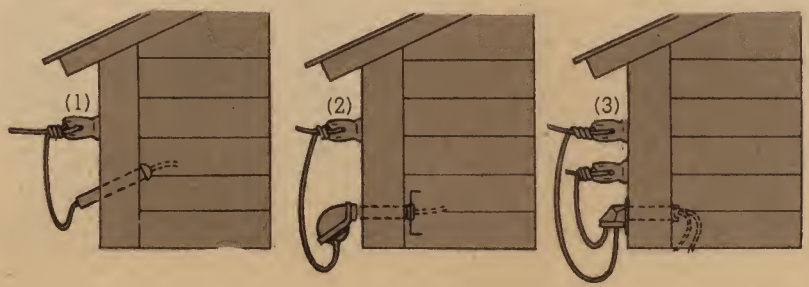
In determining size wire to use for outdoor overhead installations, you must consider mechanical strength in addition to current carrying capacity. The wires must be heavy enough to support not only their own weight but, also, the strain imposed by winds and snow or ice loads. Therefore, use no lighter than No. 12 weatherproof wire for spans up to 25 ft., No. 10 for spans up to 50 ft., No. 8 up to 100 ft., and No. 6 for spans over 100 ft. When installing wires, allow for expansion and contraction that takes place with temperature changes. If installed during a cold day, they may be pulled as tight as practical. If installed on a hot day, allow considerable slack to allow for contraction during winter.

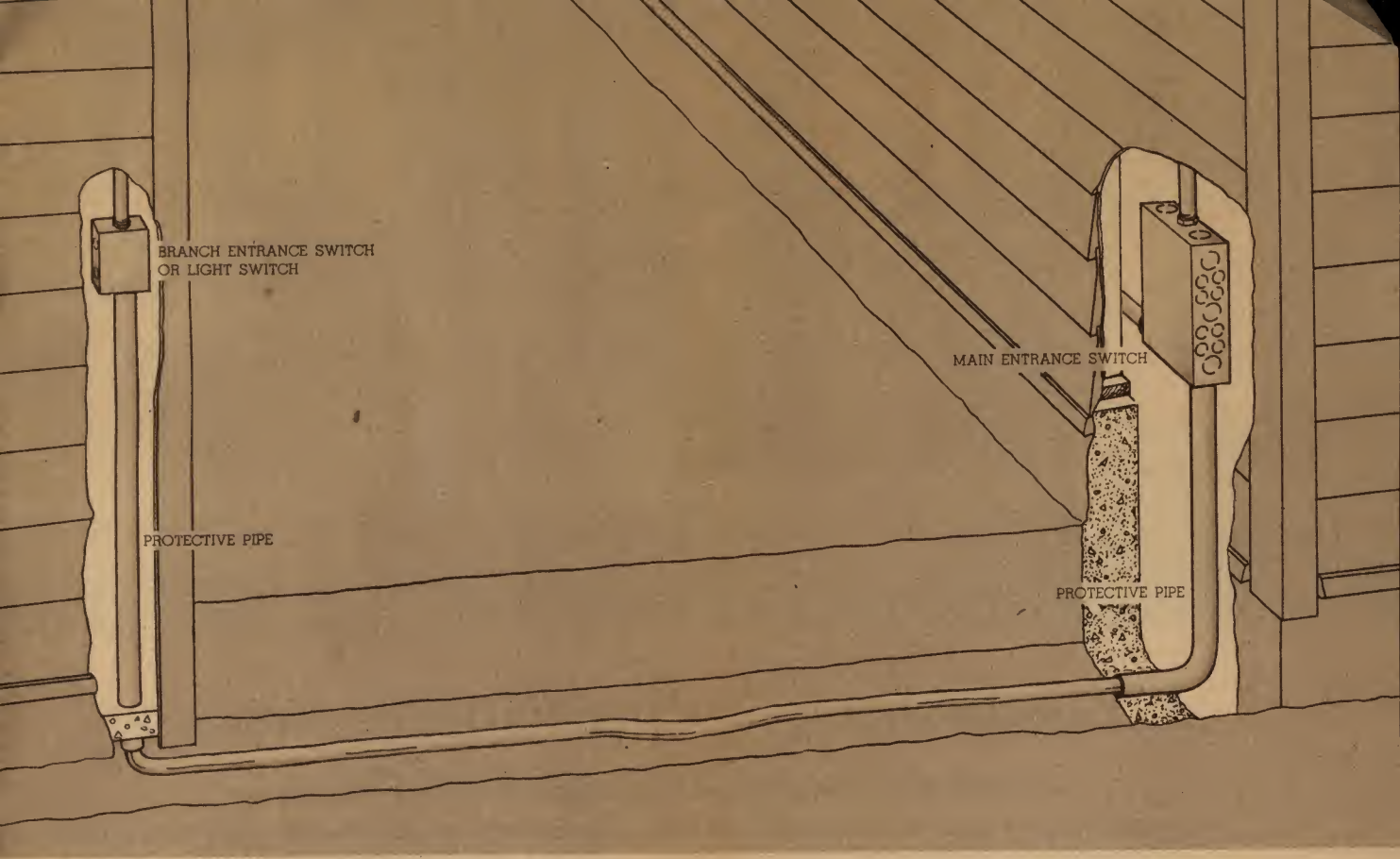
BRINGING WIRES OUT OF BUILDING

Illustrations below show several ways in which wires may be brought out of the house and into the garage or small farm building. With either of the methods, be sure to form drip loops so that rain water won't follow wire into building. Wires should be kept at least 12 inches apart and 15 feet above ground. Detailed instructions on service entrance installations are described on Pages 10, 11. The number and size wires used will depend on the amount of electric power that will be required. Figure (1) illustrates use of knob and tube—slant porcelain tube downward so that it will remain in place and keep water out. Figure (2) shows use of service head with conduit nipple attached to outlet box with locknut and bushing. Figure (3) shows use of one-piece head with cable.

INSTALLATIONS WITHIN THE BUILDING

Wiring within the building will depend upon the number and type of outlets installed. The National Electrical Code provides that all wiring in the building must be capable of being disconnected by one or more switches. Thus if one or more outlets are installed on a single circuit which is fused or protected by a circuit breaker at the main entrance switch, they may be controlled by simple toggle switches—usually no further protection is needed. If light is to be controlled from either of two points, as from house and garage, install 3-way switches—illustrated on Page 19. In this case, run 3 wires between buildings. If more than one circuit is installed, a separate entrance switch is required.





How to install underground wiring

Underground wiring is usually run from main building to garage, barns, other outbuildings or wherever overhead wires would be in the way. In general, this method produces neater installations and won't detract from appearance of property. In cold climates, it eliminates the problem of strain imposed on long overhead spans of wire by winds and heavy ice loads.

TYPES OF UNDERGROUND WIRE OR CABLE

LEAD-COVERED CABLE consists of rubber-covered wires encased in a continuous layer of lead which serves to keep moisture out—see Figure (1). To protect cable from damage, insert cable into metal conduit—make bends in conduit gradual to permit easy insertion of cable. Use 1-inch conduit for 2-wire lead cable (size 10, 12 or 14 gauge wires)—use 1-inch conduit for 3-wire cable, size 14. Bury conduit below frost line (usually 18 to 24 inches deep) to prevent condensation. Do not bury in cinders.

TRENCH WIRE consists of a single copper conductor which is covered with a layer of moisture-resistant insulation and protected by an unusually mechanically tough and water-resistant rubber type outer jacket—see Figure (2).

It may be buried in the ground directly, without use of conduit. Keep individual wires close together (use continuous lengths—no splicing), and bury at least a foot deep. Wards recommend that you lay lengths of board or other similar pad on top of wires to serve as a protection against possible disturbance from digging or gardening that may be done in the future. At end of each run, wherever wire comes up out of ground or enters building, provide a conduit for protection against damage to the wires.

PLASTIC CABLE is a tough, versatile, newer type cable—thermoplastic insulated and jacketed—see Figure (3), below. Designed especially for use underground, it may be buried in the ground directly, without use of conduit. Its highly resistant properties to mechanical damage, acids, moisture, rot and corrosion make it an excellent cable for fused underground feeder and branch circuit installations on farmsteads.

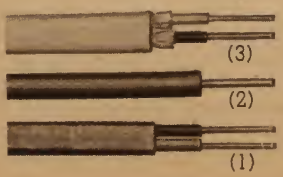
For underground installations, provide fuse or circuit breaker protection at the start of cable run, and follow same general procedure as outlined for trench wire.

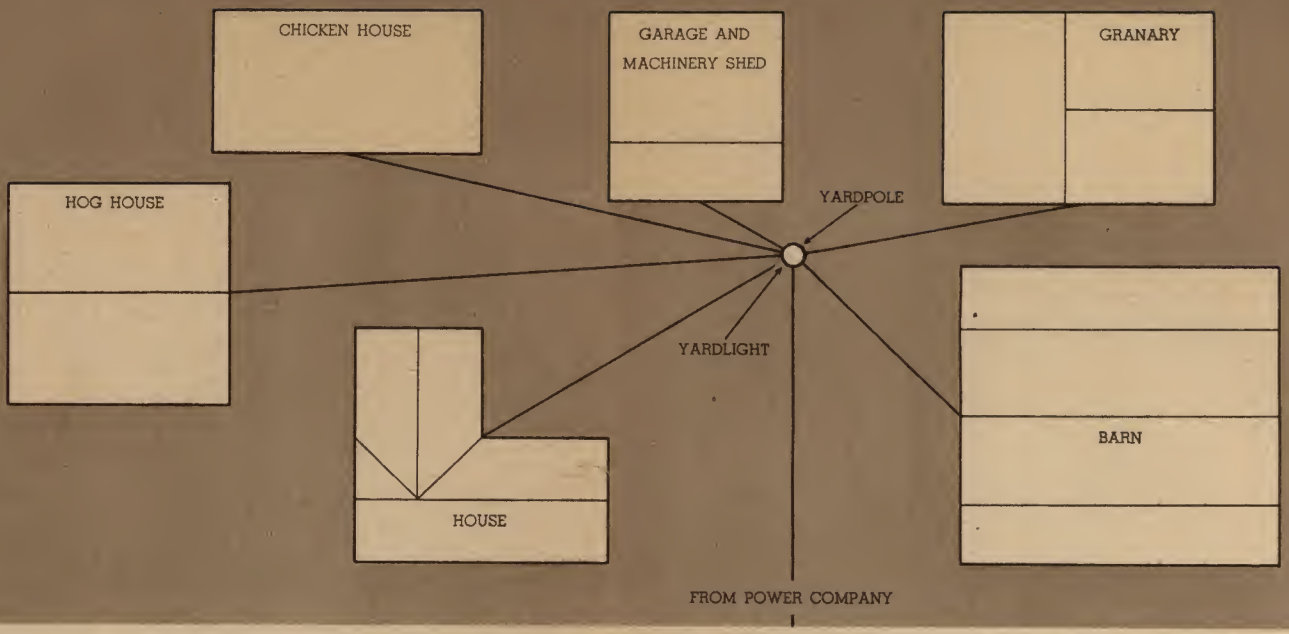
ENTRANCE INTO BUILDINGS

Where underground wires run through foundation of buildings, as illustrated above, run them through a piece of pipe for mechanical protection from damage. Ends of pipe and the point where entrance is made into building should then be filled with a waterproof insulating compound to keep water from running into building.

INSTALLATIONS WITHIN THE BUILDING

Tap into any conveniently located junction box in the house or other main building, and run wires to smaller building. Size wire used will depend upon length of run and number of outlets. Observe code provisions for overhead wiring on opposite page. Use a separate entrance switch for large loads or if more than 1 circuit is installed.





LAYING OUT A FARM WIRING SYSTEM

PLANNING THE FARM WIRING SYSTEM CAREFULLY MAKES ENTIRE JOB EASY

A CORRECT AND WELL-THOUGHT-OUT WIRING PLAN for the farm can save you many hours of work and lower your labor costs considerably. The purpose of the wiring plan is to find the total operating load of each farm building and then install and wire the yardpole so that the best efficiency and economy can be obtained from the electrical power. Draw a rough sketch of each building to be wired. Use handy Planning Chart inserted in this booklet. The most expensive lines (the largest size wire) from yard-pole to the buildings should be the shortest.

Lines from pole to all major farm buildings should have three wires. Lines to small buildings can be two wires tapped from a nearby large building served with three wires. Making a diagram like one above is helpful in deciding how and where lines will run. For example, if the barn and machine shop carry the heaviest loads (say the barn uses 12 kilowatts and machine shop uses 14 kilowatts), the yardpole should be placed so that the lines from pole to these two buildings are the shortest distance because heavier wire is more expensive, and using shorter lengths saves money. Note in chart below long runs need heavier wire due to voltage drop (see Page 9).

Operating Load Of Building	Distance from Yard Pole to Building	Recommended Wire Size to Use
Up to 3 kw.	Up to 50 feet	10 gauge
	Over 50 feet	8 gauge
3 kw to 5 kw	Up to 50 feet	10 gauge
	50 to 125 feet	8 gauge
	125 to 250 feet	6 gauge
	Over 250 feet	4 gauge
5 kw to 7 kw	Up to 50 feet	10 gauge
	50 to 125 feet	8 gauge
	125 to 200 feet	6 gauge
	200 to 300 feet	4 gauge
	Over 300 feet	2 gauge
7 kw to 9 kw	Up to 50 feet	10 gauge
	50 to 100 feet	8 gauge
	100 to 150 feet	6 gauge
	150 to 250 feet	4 gauge
	250 to 350 feet	2 gauge

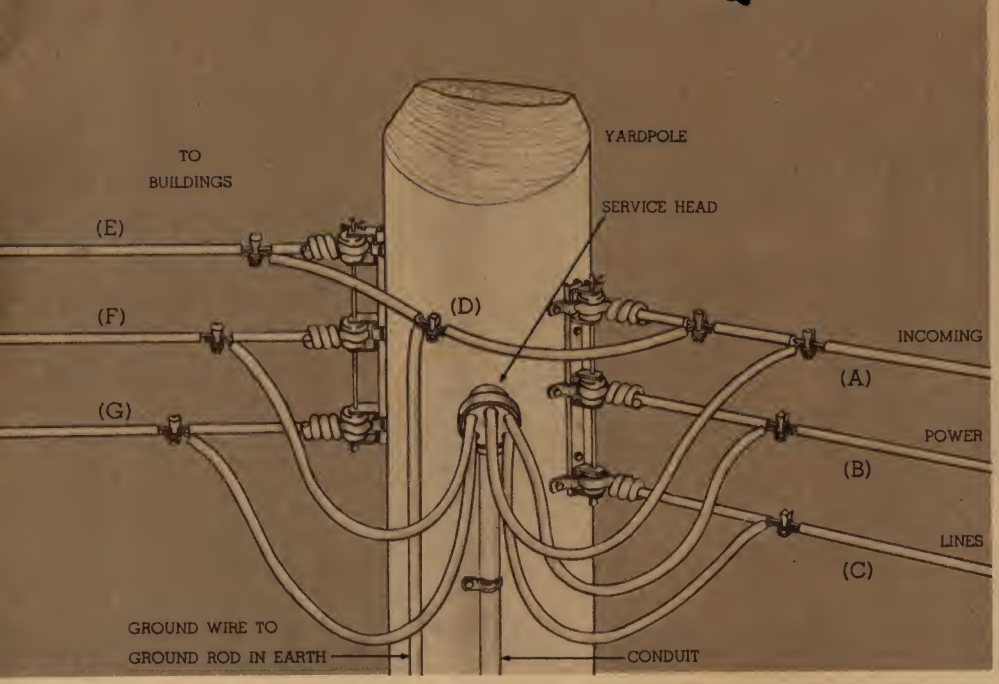
UNDERGROUND WIRING is desired by many farmers because it does not require a yardpole or wires strung overhead to buildings; bad weather and ice conditions are not a hazard. In underground wiring the meter is usually installed at the transformer and lines run from meter to farm buildings at least 18 inches under the ground level (depending on the use of the land under which they are run). For further information see Page 27. Underground wiring usually lasts longer but is more difficult to install than an overhead yardpole installation.

GROUNDING THE FARM SYSTEM. The need for a good ground is explained on Page 11, but the use of only one ground was discussed because city wiring was concerned. Farm wiring demands many grounds. There must be a ground at the yardpole (see opposite page), a ground at every farm building housing livestock, a ground at the farm house, and a ground at every building having two or more circuits.

The preferred method of grounding is the use of a ground rod driven into the earth at least eight feet. A ground rod is usually a solid steel rod (at least ½-in. diam.) with a copper coating. Ground wire should be clamped to top of rod with copper or brass ground clamp. If local inspector accepts a galvanized iron water pipe for use as ground rod, an iron ground clamp should be used. Water pipe should be at least ¾-in. diam. and driven eight feet in earth.

All grounds must be installed permanently and safe from damage. The edge of a shovel or the chemical action of animal droppings can sever a ground wire, resulting in absence of a ground and a dangerous wiring condition. There are two ways to install a ground rod, depending on locality. One way is to drive rod into earth so that a couple of inches remain above ground, leaving ground clamp permanently exposed. The other way is to dig a hole about a foot deep and drive rod into earth at bottom of hole, leaving ground clamp covered by about 12 inches of earth. Do not fill in hole until after inspection.

YARDLIGHTS, at least one, should be used on every farm. A yardlight should be on a separate circuit so that its illumination is always available. Control all yardlights from two points with 3-way switches (see Page 19).



How to wire the yardpole

THE MODERN FARM NEEDS A CORRECTLY AND ADEQUATELY WIRED YARDPOLE

THE UTILITY COMPANY usually brings wires to the farm as far as the yardpole, where the meter and a weatherproof disconnect switch are installed. The disconnect switch on the yardpole is optional, but is desirable because the entire farmstead can be shut off from one location.

If pole is to be put in new, attach switch, meter, conduit (all wired beforehand), and insulator racks to pole before raising. This makes the job much easier after pole is up. Make sure the service head on top of conduit comes up to a point above the neutral (top) wire. It is shown moved down for clearer illustration in the drawing above. See Page 10 for correct position.

THE THREE WIRES from the Utility Company run from the transformer on the power line to the meter on the yardpole. From this point on, all wires are usually supplied by the owner. Picture above shows only one set of three wires from pole to a farm building, but more of these "service drops" can be added as needed. Attach each additional service drop to an insulator rack and tap in from two hot wires coming from meter, and connect third wire of service drop to complete the job. Service drops from pole to all buildings must come into contact with nothing but their insulators (and must have a clearance of eight feet over roofs along their entire length and 10 feet above ground).

TO WIRE THE YARDPOLE, use outdoor weatherproof wire. Your local inspector will tell you what size he will approve for your ampere load. Use solderless connectors (shown on Pg. 9). All connections must be taped after installation and inspection; use self-vulcanizing rubber tape first, then cover with friction tape (or you can use plastic tape only instead of rubber and friction tape).

The hot wires (B) and (C) run from power lines into service head, down through conduit to meter and switch, then back through conduit and are attached to hot wires (F) and (G) of the service drop. This requires a service head with five holes. In some localities, it is not permitted to run wires to the meter and from the meter in one conduit. If this is the case in your area, two separate conduits must be installed from meter to top of pole (double stack construction). Consult your local inspector about this.

THE NEUTRAL WIRE (A) is always the top wire as shown above. It is wired three ways: (1) it runs continuously by means of a jumper wire (D) from transformer to all neutral wires (E) going to all buildings; (2) it runs through conduit to neutral poles of meter and switch; and (3) it runs down side of pole to ground rod.

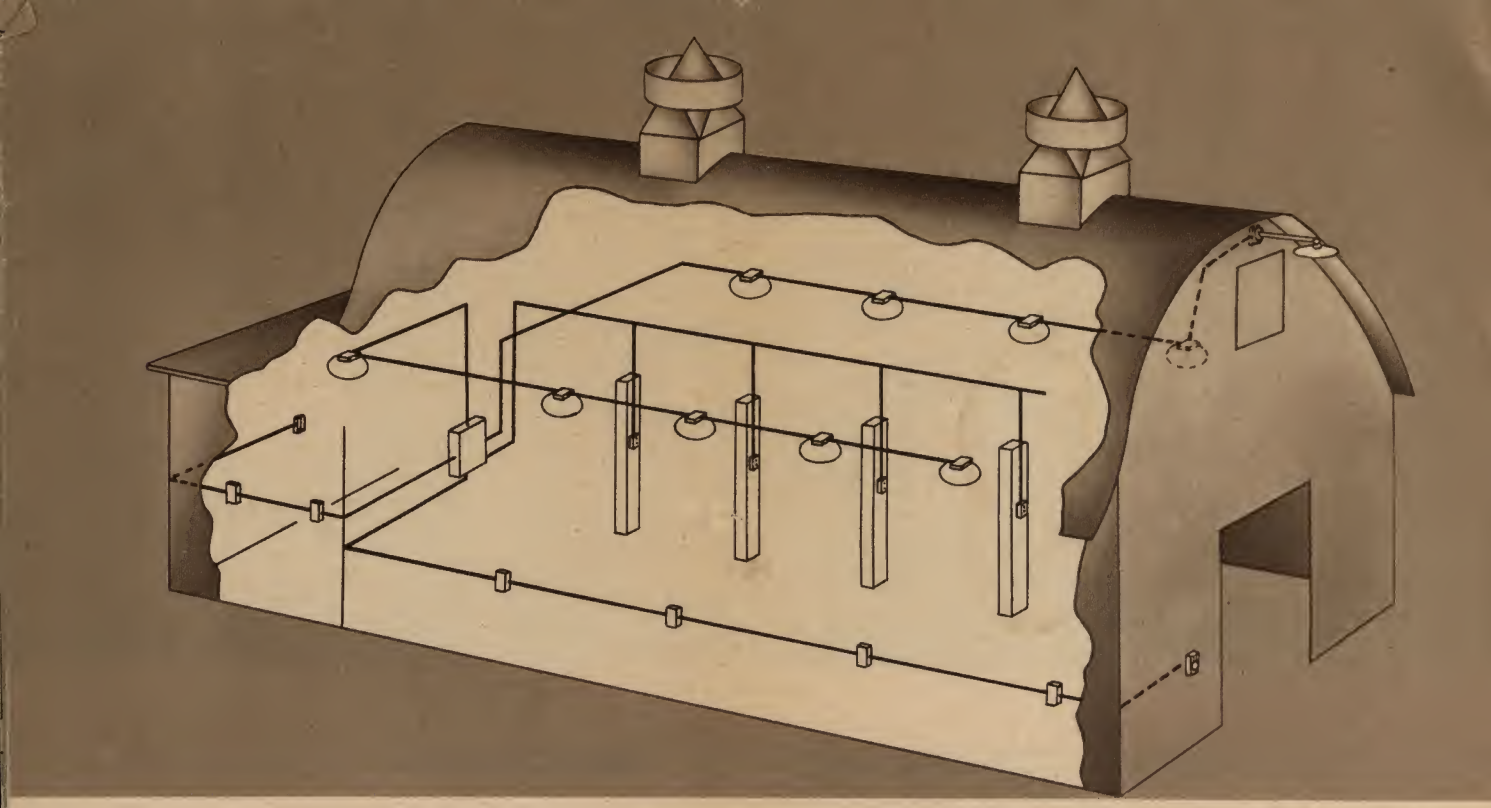
There are two ways to bring neutral wire down the side of the yardpole. One way is to run the jumper wire (D) around the pole on the side opposite the conduit and meter. Then tap the bare ground wire onto the jumper and run the bare ground all the way down the pole opposite the meter, attaching it with staples (see (8) on Page 15) every 6 in.

The other way is to run the jumper wire around the yardpole on the same side of the pole as the meter. Then tap the bare ground wire onto the jumper wire and run the bare ground wire all the way down the pole right beside the conduit, both conduit and ground wire must be held by conduit strap. Below the switch, staple the ground wire to the pole in the same manner as described above.

Your local wiring inspector can tell you what procedure he will approve. Bare No. 6 wire is usually suitable for ground wire. The ground wire is clamped to the ground rod driven into the earth (details on opposite page, illustration on Page 11).

THE YARDPOLE CONDUIT must be large enough to hold all the wires running through it. In the illustration pictured above, with five wires involved, the conduit should be at least 1¼-inch pipe. The service head should be connected tightly to top of conduit. All connections of conduit to meter and switch should be secured tightly.

INSULATOR RACKS should be firmly attached near top of pole. Individual insulators that screw into pole are sometimes used; check with your local inspector on this point. Use one insulator rack for each service drop (service drop is one set of three or two wires going to a building), and one insulator rack for incoming power lines. To insure against rack being pulled off pole by wires in bad weather, it is best to secure each rack with one through-bolt. Anchor through-bolt with heavy lug nut to prevent heavy winds or ice on wires from pulling rack away from pole.



WIRING BARNS, OTHER FARM BUILDINGS

Farm wiring systems are fundamentally the same as city installations. There is little difference today in the variety of electrical appliances found in the farm and city home. But the modern farmstead includes many additional specialized electrical devices. Hence careful planning and adequate wiring play even a greater part on the farm.

Because of the presence of livestock, higher humidity and other conditions peculiar to a farm, the following provisions must be made:

(1) PROVIDE A GROUND AT EVERY BUILDING which houses livestock, and also at every building which has two or more circuits—see Pages 11 and 28 for instructions on grounding.

(2) INSTALL A NON-METAL SYSTEM in all buildings where humidity is high or where acid-type fumes exist. Wards recommend new plastic-type non-metallic cable, used with bakelite outlet boxes, although regular non-metallic sheathed cable or knob and tube wiring can be used.

(3) PROVIDE SPECIAL PURPOSE 220-240 VOLT OUTLETS FOR ALL MOTOR DRIVEN EQUIPMENT of ¾ horsepower or over.

(4) PROVIDE SEPARATE GROUNDING for all permanently installed motors and motor-driven equipment and wherever portable tools are used.

The physical makeup of circuits in barns and other outbuildings is essentially the same as in house wiring—see Page 14 for instructions covering the installation of non-metallic and plastic cable. The exact method of installation will depend largely on the structure of barn being wired. The important point is to install cable so that it will be less exposed to mechanical damage from animals, implements etc. Wherever possible, run cable along the sides of beams and joists, rather than along the bottom. Avoid running cable at right angles across the bottom of joists. Instead, run it along the side of a beam and then along the side of a joist to the point where a light is to be installed. Protect cable with conduit when passing through floors.

LOCATION OF OUTLETS AND SWITCHES (Use moisture-proof type). Provide at least one light behind each pair of stalls. Install lights preferably between joists (rather than on bottom of joist) so that bulb will be less exposed to possible damage. Each row of lights should be controlled by a separate toggle switch. To get better use of light, equip each socket with a reflector.

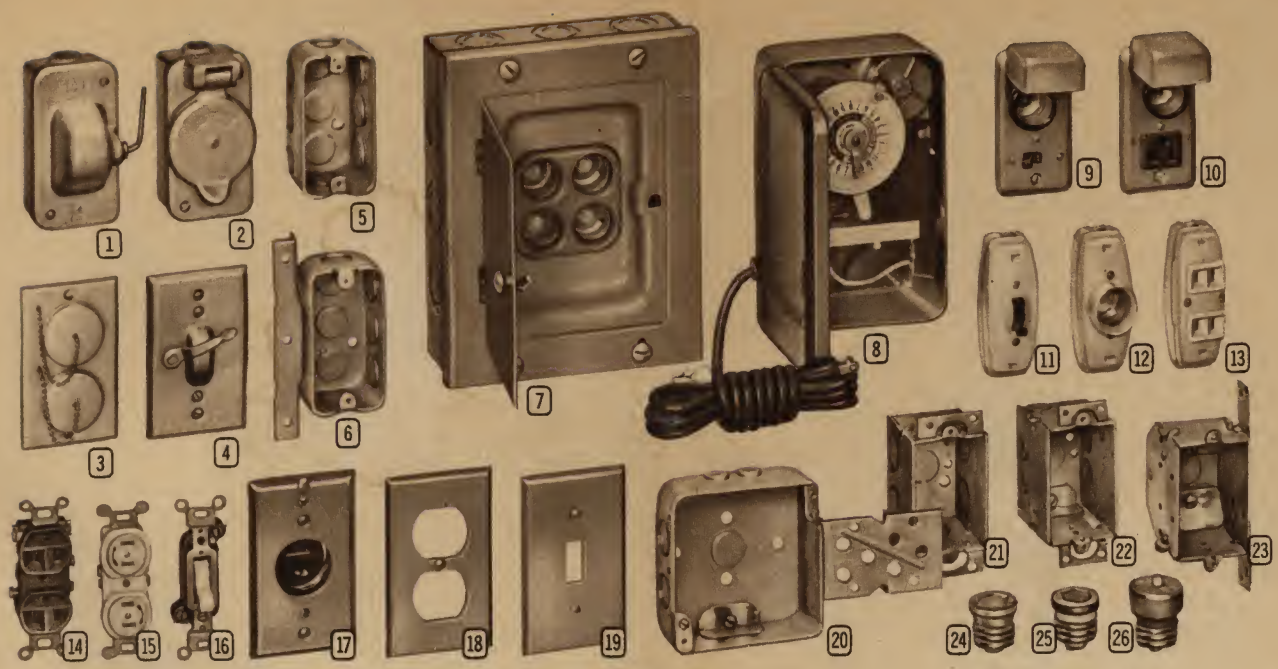
Enough plug-in outlets should be installed so that equipment can be readily plugged in. Locate both plug-in outlets and switches high enough so that they cannot be touched by animals in passing. If the barn has two entrances, you will want to install 3-way switches (see Page 19) to control at least one light from either end of barn. The milkhouse light should be controlled from a separate switch at its own doorway. Provide at least 3 plug-in outlets to accommodate milk house equipment.

On the outside of building, be sure to provide at least one weatherproof plug-in outlet of the type shown at (2), on opposite page, to facilitate the use of motors and other out-of-doors equipment. You may also want to install a yard light at either end of building.

WIRING THE POULTRY HOUSE

Egg production can be increased, especially during the winter months, by lengthening the daylight hours with the use of artificial light. A 40- or 50-watt bulb with reflector for every 200 square feet of floor area is usually sufficient for this purpose—mount lights about 6 feet above floor. Special time control switches are available that will first dim the lights and then turn them out. You simply set them for hours desired, and the entire cycle is controlled automatically. The wiring for such switches is simple—installation instructions are usually furnished.

Install separate 110-120-volt circuits for brooders and incubators, one 220-240-volt circuit for feed mixer or grinder. A 3-wire service entrance with a 60 ampere entrance switch is recommended for these appliances.



WARDS UL APPROVED WIRING NEEDS

When buying electrical equipment, plan and select carefully at the outset, and five years from now you will find both wiring and equipment still adequate. Make sure, also, that the devices you select are electrically correct—all Ward electrical equipment is UL approved and will meet REA specifications where required.

[1] SURFACE MOUNTED WEATHERPROOF SWITCHES. Enclosed single-pole or 3-way toggle switches. For barns or outdoor use. Hubs take ½-inch conduit.

[2] SURFACE MOUNTED WEATHERPROOF RECEPTACLE. Cast metal box. Use in barns or outdoors. Cap keeps out weather. Hub for ½-in. conduit.

[3] FLUSH MOUNTED WEATHERPROOF DUPLEX RECEPTACLE. Use outdoors or for damp locations indoors. Screw-on caps keep out weather, moisture.

[4] FLUSH MOUNTED WEATHERPROOF TOGGLE SWITCHES. Single-pole or 3-way type. Use outdoors or in excessively damp locations indoors.

[5] SURFACE-MOUNTED UTILITY BOX. Screws to wall surface in exposed wiring. Use indoors only with conduit, armored or non-metallic cable.

[6] SURFACE BOX WITH SIDE BRACKET. Nails to corner of studs, etc. Ideal where flat surfaces not handy.

[7] SURFACE-MOUNTED FUSE CABINET. Use with an entrance switch wherever extra branch circuits are needed.

[8] AUTOMATIC TIME SWITCH. Set to turn current on or off any part of day or night. Use for operating small motors, appliances, yard lights.

[9][10] FUSED DEVICES. Use with surface-mount box (5) and time delay plug fuses (25) to protect small motors, appliances, against burnout. (9) Single-pole switch and fuse holder — (10) Polarized receptacle (with grounding slot) and fuse holder.

[11][12][13] SURFACE WIRING DEVICES. Plastic—use with plastic cable. No ground or connectors needed —insert stripped wires. (11) Single-pole toggle switch; (12) Keyless light socket; (13) Duplex receptacle.

[14] POLARIZED DUPLEX RECEPTACLE. Has 2 current-carrying contacts, one ground contact. Grounds power tools, appliances with 3-prong plugs.

[15] NO-SHOK RECEPTACLE. Springed cap covers slots when not in use. Use in rooms where children play.

[16] SILENT MERCURY SWITCH WITH GLOWLIGHT. No annoying clicks. Glows softly in "off" position. Ends fumbling in dark. Use in baby's room.

[17] ELECTRIC "CLOCK HANGER" OUTLET. Supports clock flush with wall. Conceals clock cord.

[18][19] CHROME PLATED STEEL COVER PLATES. Sparkling, (18) Double receptacle plate; (19) [illegible] switch plate.

[20] 4-IN. SQUARE BOX WITH BRACKET. Nails to stud. Use clamp-type for non-metallic cable. Without clamps, knockouts take connectors, for cable or conduit.

[21][22][23] SWITCH OR RECEPTACLE BOXES. Use in dry locations, indoors. With removable sides for ganging 2 or more boxes.

(21) WITHOUT CLAMPS, SQUARE CORNERS. ½-inch knockouts take cable connectors or conduit. Adjustable mounting brackets for flush installations.

(22) WITH CLAMPS, SQUARE CORNERS. Use with non-metallic or armored cable or loom. Adjustable brackets.

(23) WITH CLAMPS, BEVELED CORNERS. Fits easily into wall openings in old work. Use with non-metallic cables or loom. Dry wall bracket nails to stud.

[24] STANDARD PLUG FUSE. Use to protect against circuit overloads.

[25] FUSETRON PLUG FUSE. Absorbs temporary overloads as when starting motors, power tools, washer, etc. yet protects fully against dangerous overloads, shorted circuits.

[26] MINIATURE CIRCUIT BREAKER. Ends fuse changing. Screws into fuse socket—push button to restore current.

MAKE WARDS YOUR HEADQUARTERS FOR LIGHTING FIXTURES

COMPLETE YOUR MODERN WIRING JOB by installing smart, modern Wards lighting fixtures. Wards have a fixture for every lighting need, from porch lights to crystal chandeliers, including the newest in recessed and fluorescent lighting, modern bent glass and reel type fixtures . . . all at Wards traditionally low prices. Fixtures are UL approved, come completely wired, ready to hang. Solderless connectors and wiring instructions are included.

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Ward